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VALUE OF THE WORLD'S FAIR TO THE AMERICAN PEOPLE.

By Andrew Carnegie.

THE great exhibition has come, triumphed, and passed away. The unrivalled mass of beautiful structures which seemed rather to have dropped from above than to have been slowly built up from below, are being rapidly dismantled. Our revels are ended. Prospero's wand has broken the spell. The cloud-capped towers, the gorgeous palaces, have dissolved; but the impression made by these greater than Aladdin's palaces remains, even more vivid than when received. Every one who was privileged to spend days and evenings in windings in and out, through and among the palaces of the White City, and especially to saunter there at night when footsteps were few, has the knowledge to treasure up that he has seen and felt the influence of the greatest combination of architectural beauty which man has ever created.

The universal verdict is that no previous exhibition had ever scored such a triumph. Equally universal is the gratification that it was held in Chicago. When it was decided that the discovery of the country by Columbus should be celebrated, it seemed to be taken for granted at first that there was but one proper place for the ceremony. Soon, however, a second claimant intimated its advantages, but the East was slow to realize that there was anything to be said for the western city. The people of the eastern Atlantic States travel far too little westward. The mention of Chicago as a possible site generally created a smile on the face of the citizens of New York. There were a few, however, from the very first who saw that irrespective of the merits of the two cities it was due to

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the great West that the forthcoming exhibition should be held there. These fair minded people argued that the East had had its celebration in Philadelphia. The revolution in the taste of the people which that display effected was surprising, and the West, it was felt, should have an opportunity to profit through the same means. To day not only do the citizens of New York agree that in every way it was best that the choice fell as it did upon Chicago, but a vast majority go much further and admit that it would have been impossible for New York to equal the success achieved had the exhibition been held there, or indeed anywhere save in the western metropolis,—the center and headquarters of Triumphant Democracy. All honor then to Chicago. Her action throughout entitles her to rank as the most public-spirited city in the world. There are other proofs of her claim to this proud preëminence in the magnificent sums which her citizens vie one with another in providing for the highest wants of a population soon to be numbered by millions. Fourteen millions of dollars given or bequeathed by her citizens are to-day being spent for the good of the city, in patriotic pride of which every Chicago citizen seems to share. Amid much for which this very modern community serves as a model to others let the possession of a salutary civic pride be carefully noted and credited.

The exhibition is closed. What then have been its lessons and its value to the Republic? Others are to give the readers of THE ENGINEERING MAGAZINE in detail their replies to this inquiry. Each writer selected for this work is a foremost authority in the branch he is to consider. So eminently qualified are these men for the task that one finds himself looking forward with pleasurable anticipation for their respective contributions to the Magazine. Happily the modest part assigned the writer by the editor is only to give his impressions of the result as a whole, which requires no special knowledge.

First, then, the grandest thing about the exhibition was the scene from without. The frame was finer than the picture, and more valuable. The temple viewed from afar was more precious than the temple viewed from within. This is high praise. The first impression of the Taj seen from the garden renders minute inspection of the interior common-place in the extreme. The sight of the Parthenon taught the Greeks more of the beauty in art than anything which it contained. The sight of Edinburgh castle, says Ruskin, influences every Scotch boy who has soul enough to be in-

fluenced, and so the dazzling glimpse of that exquisite scene in Jackson Park, the first to greet the eye of the beholder, will be the last to fade from his recollection. I make bold to say that after every work of art, every ponderous engine, every invention, everything that proved the cunning brain and hand of man, has faded away, the general effect of the purely artistic triumph attained by the buildings and their environment will remain, vividly defined in the memory and recorded there unmixed with baser matter. The best reason for heartfelt gratitude and pride is that the notable success of the Chicago exhibition was not material. That our electric display dwarfed what all nations of the earth combined could produce; that our transportation department was a revelation; that the heap of silver, lead, coal, and iron-stone was prodigious; that there were temples made of corn, and highly artistic effects produced from cereals,—all this was much from one point of view. But from the standpoint of the status of the Republic as a civilized nation, a candidate for supremacy among the nations in the region of art and civilization, these material triumphs pass as a matter of course. We were expected to excel, in these. The grand point is, that incontestable as was our success in these material things, it was yet not so strangely or so unexpectedly incontestable as our triumph in the higher realm of artistic development. "Sir," said an eminent Frenchman, "these buildings at Chicago seem as if they must have been produced by us in Paris, and those that we boasted of in Paris seem now as if they must have been designed and erected in Chicago."

There are three points upon which the success in art was surprising. One I have indicated—architecture: the design and grouping of the buildings themselves, especially in connection with the utilization of the water, which made the scene unique. In sculpture some very notable works appeared. The chief successes in statuary were, of course, in the groups upon and around the buildings, but the work exhibited within was in some instances very remarkable. The American school of sculpture has established itself through this exhibition.

In another department of art the surprise was even more complete. I refer to the American school of painting. There has never been brought together before such an array of the best paintings of American artists. It must, of course, be remembered that the foreign pictures were not of the best, while the American were of the very best; but even keeping this in mind, the result of

careful and repeated examinations made by many experts was that even with the best of the foreign modern masters the best of the American modern pictures would hold their place. One American collector was able to exhibit so great a number of the gems of the collection that I could not help envying his position. I did not know any one connected with the entire exhibition who can more truly be considered a public benefactor than this artistic gentleman, who has evidently for many years had faith in the genius of his countrymen, and has quietly purchased the best examples of their work as these came forth.

Many congresses assembled in Chicago upon the invitation of the exhibition authorities. Only one of these, I think, is destined in the future to affect the stream of tendency to any great extent. This is not said to disparage any other assembly, because every little aid to a good cause helps. But the Parliament of Religions was an original idea. Never before have the representatives of the various and different religious beliefs appeared upon a common platform upon terms of perfect equality to explain and support their respective forms of belief. That the idea of such a commingling arose, is a cheering sign of the progress the race has made, for within the lifetime of many still living it would have been scouted as almost blasphemous. It is not so very long ago that we western people modestly assumed that we alone had the truth, the whole truth, and nothing but the truth, and that the Unknown had kindly favored us to the exclusion of the vast majority of his creatures. To-day, it seems that the various sects of Christianity are ready to believe that an all-merciful creator feeds his people, whom he has created in the various lands of the world, with the food which he thinks they are severally best adapted to receive and assimilate for their good. It was a notable sight to see the devout worshipper of the East explain to his rather egotistical brother of the West that the heathens have not been left without heavenly guidance. I wondered that some of our own people did not quote Matthew Arnold's appropriate lines to prove that the Christian poet was not less advanced than these heathens in the view which they take of the wisdom and care which the Father of all takes of all his children. Christian and pagan could have united in reciting these lines:

"Children of men! the unseen Power whose eye
Forever doth accompany mankind,
Hath look'd on no religion scornfully
That men did ever find.

Which has not taught weak will how much they can?
Which has not fall'n on the dry heart like rain?
Which has not cried to sunk, self-weary man,
Thou must be born again."

The Parliament of Religions may be credited with having set in motion many forces tending to the harmonizing, and ultimately to the unifying, of the principal forms of religious belief. At all events, it seems to render the differences between the various sects of Christianity much smaller than they were before.

The favored traveler who had done the sights of the world was disposed to jeer at the Midway Plaisance, but I doubt if any department of the exhibition gave as much pleasure and even instruction to as great a number as this unique feature did to the vast majority who cannot hope to travel abroad. The Javanese village, the street in Cairo, the German village, and even the sight of the reproduction of Blarney castle and many other national scenes were object lessons which gave the best possible substitute for personal inspection of the original. The longing of the American to visit the older countries of Europe is as general as it is strong, but only about 30,000 out of 65,000,000 people go abroad yearly and fully one-half of these have been before, so that not more than 15,000 fresh visitors go each year. Consequently only a very trifling percentage of the whole mass can ever see with their own eyes the scenes about which they read so constantly. None of the arrangements of the managers of the Chicago exhibition seem to have been wiser than the bringing over of correct representations of the lives and homes of the various peoples of Europe and Asia.

From a national point of view, the chief good from such an exhibition as we are just now considering arises from the gathering together of the people of the different sections. The few who travel much fail to remember that the masses of the people travel but little. Their reunions are confined to the immediate neighborhood. At the most, a State fair draws them together from the same State; but at Chicago the citizens of different States, with their families, were brought into close and intimate relation. Every citizen became not only prouder than ever of his country, of whose position and greatness the exhibition was the outward and visible symbol, but he became acquainted for the first time, perhaps, with his fellow countrymen of other States.

The impression made by the people *en masse* was highly complimentary to the American. I never heard a foreigner give his impression who failed to extol the remarkable behavior of the crowd,

its good manners, temperance, kindliness, and the total absence of rude selfish pushing for advantage which is usual in corresponding gatherings abroad. The self-governing capacity of the people shone forth resplendently. The foreigner's verdict is that without official direction or supervision every individual governed himself and behaved like a gentleman. So much for universal education.

In a federation so extensive as ours this drawing together of the people of the States is a work of great difficulty, and yet it is of infinite importance, for the masses of the people should not grow up without having in their midst living links who have met their fellow-citizens from other States and found them much like themselves, and in harmony upon one point at least,—their intense Americanism. Every plan should therefore be encouraged which draws the people of the different States together, and an exhibition like that just held at Chicago is by far the most efficacious of all modes. The seventeen years that passed between the Philadelphia exhibition and that at Chicago was a period quite long enough. At least once every twenty years the people should be induced to gather from all the States as they did at Chicago, and, if possible, each section of the Union should be favored by having this national reunion—East and West, North, South, and Center.

Meanwhile let every citizen for himself, and every State for itself, and the Union for the nation as a whole, cherish a deep sense of the invaluable service rendered to the Republic by the people of Chicago, our "Western metropolis," of which no American can hereafter fail to be proud. It undertook a great task, encountered unexpected difficulties, surmounted all obstacles, and ended by giving the world its most notable exhibition.

EFFECTS OF THE CENTENNIAL EXHIBITION.

By Alfred T. Goshorn,

Director-General of the Centennial Exhibition, 1876.

THE World's Columbian Exposition has passed into history, and has taken its place beside the other great exhibitions. Its active presence is gone, but a host of impulses, founded upon impressions received there, remain as a vital heritage of the World's Fair. The amusements, the spectacular attractions of the moment, all these diversions have passed away. In their place we shall now find showing themselves from time to time whatever permanent impressions were there received by our people. Some of these are already patent, particularly those of an esthetic nature which originated in the architectural and sculptural beauty of the grounds. Many of the other impressions are not now to be discerned, much less measured. They have in large part not yet crystalized into impulses bearing actively upon our national culture and industrial welfare. In due time, however, we shall be able to trace this or that to the Chicago exhibition, as we do similar lines of development back to the Centennial Exhibition in Philadelphia. Many of us may have suspected in the winter of 1876 that our arts and industries had in the preceding summer received a profound shaking-up, but no one could then know how powerful and all-pervading the stimulus was destined to be. It seems all so clear now, that we find difficulty in recalling the conditions which prevailed here prior to 1876. We have become so accustomed to the state that has resulted from nearly twenty years of progress upon lines then laid down, that a clear retrospect is almost impossible. There may be changes as great, innovations as surprising, already started by the Columbian Exposition, and we may be as little cognizant of their real meaning as in 1876 we were of those following the Centennial. International exhibitions are among the most effective of national educators. They tend to raise each of the coöperating nations to the level of the highest in artistic, industrial, and scientific advancement, and they stimulate that one to still more energetic efforts to preserve supremacy.

The Centennial Exhibition found the American people engrossed in the development of the natural resources of a country

whose riches still remain unmeasured. Art, literature, and esthetic culture, of which some real appreciation existed in the rather settled civilization of the Atlantic States during later colonial times and the earlier portion of this century, could, toward the middle of the century, offer to young men but weak inducements compared with the dreams of wealth to be realized in the fabulous West. From Maine to California the country became one vast field in which material prosperity was the idol. The civil war strained every sinew. When it was over this exceptional energy was released in the old materialistic channels. We ran along to the panic of 1873. Recovering somewhat from that by 1876, we were in a condition most favorable to the reception of new impulses. The inflation of war-times, and the speculative activity of the ensuing years had given way to a more conservative spirit. We became ready to believe that culture and taste might be of greater value in life, and that pure material prosperity might be less fit to absorb our entire interest. Accumulated wealth provided the means of gratifying tastes thus created. Accordingly, when the Centennial Exhibition was opened, the American people—particularly those of the eastern seaboard—were, more than they realized, ready and eager to enjoy the many products of industrial art that were sent to Philadelphia from Europe and the Orient.

The fundamental principle of the Centennial, that to which the organization and the administration invariably sought to conform, was a desire to place before our people the products of the world, particularly those of the art industries, in such order that powerful educational influences might be brought to bear upon our country. The Exhibition was planned for the exhibits, for which it was the framework, the setting, or the background. With this in mind, spectacular attractiveness was made secondary. Nothing was tolerated that could detract from the instructive force of the articles placed on exhibition. We felt that the exhibits were of such supreme interest that nothing else need be resorted to to draw the people. There was in these quite enough to occupy the exclusive attention of visitors. The lessons to be learned from these manufactures were of such importance, as bearing upon our advancement at that time, that it seemed wise to give little thought to other things. The effectiveness of the Centennial as an educator is no doubt largely due to the concentration upon this one fundamental aim,—to this simplicity of purpose.

The classification of exhibits, the installation, the system of

awards, were all based upon the educational influence of the objects shown. The judges were experts, and their reports were statements of the excellence possessed by the articles upon which they recommended awards. The published reports of the jurors are records of this or that merit in objects compared with one another. The award of uniform value was accompanied by an expression of opinion that in few words went to the heart of each case. It is safe to say that by general consent the Centennial Exhibition was unusually successful among exhibitions in its efforts to systematically educate its visitors. The impulses that went out from it to all the industries, all the arts, in science, and in general culture, gave new vitality to American civilization. Its work was well done, not only because it was wisely planned and guided, but because the people were ready to receive understandingly the lessons it presented, and because those seem to have been the lessons we actually most needed at that stage of progress.

It is not necessary to review in detail the advancement made in science, art, and the industries in the years from 1876 to May, 1893, when the Columbian Exposition began to exert influence.

It is sufficient in a general way to indicate the tremendous movement in the direction of esthetic culture that has raised us from a people absorbed in the pursuit of material prosperity, of utilitarianism, to a condition in which we have more than begun to appreciate the higher refinement that art brings to our lives, individually and as a people. In 1875 many objects we prized for utility were ugly, and we did not know it. Now, we demand that the articles, of whatever kind, shall be appropriate not in utilitarian construction alone, but shall also be in keeping with that "eternal fitness" which is perhaps the closest definition one can give of taste. We learned in Philadelphia a great deal about the natural resources of our continent, and much that led to the scientific development of industries, but we learned also that we had overlooked taste.

The Centennial, naturally, made radical changes in our foreign trade. Many foreign manufactures, until then unknown to us, soon became regular articles of commerce, and the artistic merit of the importations improved from year to year with the growing demand. It is difficult to realize now the rapidity and volume of this influx, and the changes in taste resulting from it. Every application of art was embraced in it, until now the United States has become one of the great markets for the products of the world's

art industries. We are so familiar with these articles in the shops of our cities that it seems impossible that until the Centennial Exhibition they were almost entirely unknown to us. Importers familiar with European markets say that to-day American women are more exacting, more critical, than the same class of buyers abroad. I do not refer so much to the very expensive objects of art, bought by collectors, as to the articles of regular use, such as table ware, decorated pottery, and porcelain, glass and silverware, for example. Of careful collectors of the finer works of art we have also our share,—a hundred now where there was one in 1875. I do not mean only those collectors whose means enable them to buy where and whenever they find, but rather those who have that characteristic faculty of ransacking and saving from loss, or destruction, the many valuable objects of which the purchase price is not the first evidence of worth.

Out of this has grown a series of museums large and small, in which private enterprise has undertaken the educational work in the arts, the industries, and in natural science, which, in Europe, is carried on with the aid of public funds. The growth of the collections in these museums since 1876 is astounding. Those who founded and who have administered them have succeeded beyond expectation in accumulating instructive specimens of all sorts. Consequently, these institutions have in a few years become powerful educational centers, expanding farther and farther the impulses which started in Philadelphia. A number of these museums bear a more creditable comparison with some of the older museums of Europe than one would at all expect when recalling the few years of their existence. For instance, the achievements of the ancient world and those of the Renaissance,—in sculpture, painting, and the applied arts,—which were unknown to us as a people twenty years ago, are now intelligently studied in collections of casts and similar reproductions, and in not a few originals.

Alongside of these museums have sprung up in even greater numbers art schools and technical schools. There is hardly a city of any size that has not one or more of these schools, studiously training each year its hundreds of young men in art and science. This striving for skill in artistic and technical expression is but one branch of the great fundamental movement we are considering. Art schools in New York, Cincinnati, Boston, St. Louis, Philadelphia, and Chicago present opportunities for the development of

ability to draw, paint and model, and design, already adequate to carry the pupils to the point where they may become self-reliant students able to direct their own further training, and prepared to apply to their own uses the lessons of past and present achievements in Europe.

Nor did the Centennial affect art education alone. The impetus extended as well to general education. It could not do otherwise, for the very foundations of our civilization were affected. Before 1876 we were a provincial people. However able, however intelligent we may have been, our ideas and sympathies were local, not cosmopolitan. There was a prevailing contempt for the foreigner and his slow, old-fashioned ways. We prided ourselves that America was American, and felt irritated by the foreigner's criticism, often expressed, that we were provincial. The Centennial Exhibition removed much of this spirit, and marked the introduction of business and social relations with foreigners, out of which has grown from year to year a greater respect for the culture which European life has attained after centuries of experience. What we lacked of that culture we have set ourselves to acquire. The manly recognition of one-sided development, and the determination to broaden ourselves, is characteristically American, and has gained for us the respect of the world of culture. Of course, university and college life has been influenced by this change of standpoint, and these institutions have sought to respond to the demand. To assure one's self, compare the Harvard, Yale, or Princeton of to day with that of 1875.

A reflex movement occurred in the rest of the world, especially in Europe, which found itself brought by the knowledge of 1876 into a different relation to the United States. The Philadelphia exhibition was an opportunity to show foreigners the sources and accomplishments of our country in a way they had not previously seen them. Our exhibits were a revelation to Europeans, as theirs were to us. The social and commercial relations thus naturally established, and the ties connecting our large population of immigrants with Europe, have carried into Europe many American ideas, social, political, and commercial. In this exchange our gain s by far the greater, for the old word is sluggish and less responsive.

So much has recently been said in reference to the development of domestic manufactures that I need write little more here. Not only has there been a marked progress in all those industries

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in which art is applied, but it has extended to others as well. Machinery, of which our exhibit in Philadelphia was strong, has advanced upon some lines that were suggested by foreign exhibits at that time. Its construction has become more scientific, its uses have been better directed, as our knowledge of methods grew. More exact calculation, and less inventional inspiration, enters into it now. In other directions likewise knowledge of European methods has placed our industries upon a more intelligent footing. Consequently, we are more and more able to compete in foreign markets, and our foreign trade is destined to change largely from cereals and food products to manufactures.

This close association with Europe has had important consequences upon our business methods. The direct and constant exchange of business between New York, London, Paris, and Berlin has made our methods more exact, more regular, and has resulted in an organization of business marvelously effective in production, manufactures, and distribution. No enterprise is now so great that capital cannot be provided for its execution.

These are some of the direct and indirect effects of the Centennial Exhibition, which in some instances actually created movements, and to others already existing gave a vitality tenfold greater. As I have said, this impression was made upon the very root of our national and social life. The years since 1876 seem, indeed, to form part of a period of reconstruction such as rarely occurs in the life of a people. This progress paved the way for the great exhibition that has just closed in Chicago, and which may be said to mark our national attainment along the lines of the impulses of the Centennial. The architectural features of Jackson Park were impossible of execution in 1876. Nor could they have been understood and appreciated at that time. The problem of buildings in Philadelphia was to house exhibits, and not to attempt an architectural display. We abandoned the intention of carrying out a scheme of elaborate architecture, partly because of the expense, but principally because it did not occur to us that anything could or should be made of more importance than the exhibits themselves. Accordingly, our buildings and grounds were simple, dignified, and appropriate to the uses to which the place was to be put as a receptacle for exhibits. They were attractive, and in an unostentatious way beautiful, but one felt that they were of secondary importance in comparison with what was to be seen in them. The result was that the visitors did study the exhibits, looked at them

closely and intelligently, and were amazed at what the old world disclosed before their eyes. It was the lesson that time has shown we then needed,—and the fact that the Centennial taught it was its justification.

The problem which the promoters of the exhibition in Chicago this year had to face was a different one,—different by reason of the intervening progress. More was demanded by the esthetic culture of to-day. Art was felt to have been the spark that had vitalized American life in 1876, and to art again Chicago looked. The local directory turned not to the minor industrial arts, but directly to the great art of architecture, and they determined that so far as lay within their power, the exhibition of 1893 should show to the American people an architectural spectacle that should stand foremost among the artistic achievements of modern culture; that the American people should see what the accumulated art of centuries means; and that the world should see the mark to which American civilization aspires and has in part attained. The connection of this with the Centennial I hope to have made partially clear. Of the future little can safely be predicted. We know what the Centennial did. We know how profound an impression the buildings in Chicago have made. We can but look forward with confident expectation that the impulse of 1893 will be similar in character and in vigor to that of 1876.

THE ARCHITECTURAL EVENT OF OUR TIMES.

By Henry Van Brunt.

THE greater buildings of the World's Columbian Exposition were created primarily to accommodate most worthily a vast international display of works of industry and art. They not only fulfilled this purpose, but they expressed in terms of architecture the highest civilization of our times. It is evident that this result was attained, because no other architectural demonstration in history has received such cordial recognition by the people as an intelligible exposition of fine art or enjoyed such a universal tribute of respect and admiration. If it had been of a nature to be appreciated only by critics, and had been received by the people with indifference, it would have been merely exotic, and in no sense representative of the modern spirit in its best estate.

The study of architecture in modern times has all the elements to be derived from a liberal education; for the study not only embraces the acquisition of a scientific and artistic technique, but, as its scope must necessarily cover an exhaustive survey of all the achievements of the past in this art, and their close connection with the development of nations and the genius of races, it must be, to all who pursue it seriously, an enlargement, a strengthening, and a refinement of the mind. The opportunity presented at Jackson Park for a manifestation of the results of this liberal education in the greatest of the fine arts was unprecedented; it was practically unrestrained by the usual cramping conditions of practice in architecture. There was no whim or prejudice of a client to be ingeniously accommodated, and no restrictions of economy or commercial convenience to be reconciled to art. On the contrary, from the beginning, the architects who were fortunate enough to be called to this great work were encouraged by the large, intelligent, and generous sympathy of the local board of directors, and by the superb public spirit of the citizens of Chicago. But this sympathy and this public spirit might easily have furnished a dangerous initial force, if it had not been made effective in the interests of highest art and brought home to the architects by the professional enthusiasm, by the noble and disinterested zeal of their brother, Mr. D. H. Burnham of Chicago,—without whose

phenomenal organizing power, breadth of view, and personal force, as director of works and chief of construction, it is not too much to say, the architecture of the Exposition of 1893 would have been impossible. Indeed, in this one instance at least the art was left to its own inspirations. The results of these unprecedented conditions have been justified by their effect upon minds hitherto inaccessible to appeals of art.

If the conscientious study of this art is, as I have said, a liberal education to the architect, this great demonstration had, to an appreciable extent, a similar effect upon the public. Much of its carefully-studied detail was lost to the masses, of course; but there was some general quality in it which moved all minds to unwonted emotions and aroused a sort of pleasure and exaltation of sentiment which they had derived from no other experience of life. To millions of intelligences, from the highest to the lowest, the architecture of Jackson Park, with its subsidiary sculpture and painting, was a revelation of the power of art, and millions of lives were made larger and fuller by the experience. It has been often questioned whether architecture has not in modern times ceased to interest the people as it did in the great eras of the past. They have for the most part been indifferent to its most monumental manifestations because they have not understood them. The Exposition of 1893 apparently restored this art to the people, and rehabilitated it as one of the acknowledged agencies of civilization. Indeed, it has perhaps restored architecture to architects, in giving to them a memorable object-lesson of the immense impressiveness of loyalty to those established types of art which were connected with and expressive of the greatest eras of human history, and of the importance of subjecting the inventive powers of design to the chastisement and discipline of serious study.

The most valuable retrospect of the architecture of the Columbian Exposition, therefore, is to be obtained far less from a technical description, which might not be understood, or from a general description, which could not describe, than from a brief analysis of the special architectural conditions which awakened an interest so genuine and so general. The architects of the great buildings concerned themselves only to create once for all pure architecture according to the highest standards—an architecture which should be its own excuse for existence. They did not aim to astonish or to amuse, and in fact hardly expected to be appreciated save by a few, who, by training and special culture, had established intelligent

and intelligible ideals of art. They had been so accustomed to public indifference that the consensus of interest which was presently aroused by their work had all the force of a surprise to them. They found, for the first time in their experience, that at least the broadest effects of art which they had aimed to establish had at last found entrance into the minds and hearts of the multitude with a new enlightenment. They hoped for the usual award of an approving artistic conscience; they enjoyed also the unexpected award of popular approval. Their architectural epic, though expressed in a learned tongue, in a language of complicated historical conventions, was not entirely unintelligible even to the untrained mind. This is at once an encouragement and an incentive to the practice of pure art.

The secret of this tardy but most effective awakening of the public mind to the consciousness of architecture as a fine art is easily revealed. In the first place, the great creation at Jackson Park was made intelligible to the people by its harmonious unity. But if this unity had been mere uniformity, though it would still have surprised them by reason of its magnitude, it would have left no durable impression of pleasure or profit, because its monotony would have fatigued the eye, and its want of imagination would have left the higher emotions untouched. If one side of the great formal court of ceremony had exactly reflected the opposite side, no one but a precisionist, or a drill-sergeant, or a mathematician would have taken any delight in it. It is clear therefore that, in the second place, another quality besides unity,—namely diversity,—was an essential part of the architectural scheme. But to make diversity consistent with unity,—or, in terms more familiar to the critic, to obtain variety in unity,—is perhaps the most difficult problem in architectural composition; indeed it is a problem which, on a large scale, can hardly be solved by any single mind without affectations of contrast which, by their obvious artificiality, their conscious pose, defeat the great object to be obtained by this rare reconciliation of opposing qualities. The great architects of the Renaissance, especially after the beginning of the seventeenth century, generally aimed at exact correspondences in their larger and more important compositions, as in civic squares and in the courtyards of palaces; but they never succeeded in producing results as interesting and poetic as those almost unconsciously achieved by the first Renaissance builders in the sixteenth century, who, fresh from the old Gothic or Romantic freedom of habit in

design, would not suffer themselves to be constrained by the rigidities of a classic formula, as all their successors were. Consequently, in the third place, a coöperation of distinct and sympathetic individualities, trained alike in the theory and practice of architecture, was necessary, so that each, being restrained by the adoption of certain leading conditions of composition, common to all the buildings, could more or less unconsciously differentiate his work from the rest by the operation of the personal equation. This differentiation, being the result of natural differences in temperament, mood, and experience, secured the necessary quality of unaffected variety, without offense to the quality of unity, which, in its turn, was preserved by subjecting the leading ideas to each design to a general architectural scheme.

Confining ourselves for the present to the consideration of the Court of Honor, a coöperation of the most sincere and fruitful character was obtained and a national character given to the enterprise by the judicious and generous selection of five architects outside of Chicago, who by reason of extensive practice and wide observation had proved themselves capable of undertaking serious and difficult work of this sort and of comprehending the fundamental importance of discipline in any collaboration of art. The architects so chosen and the buildings assigned to each were as follows: Richard M. Hunt (New York), the Administration building; Peabody & Stearns (Boston), the Machinery building; McKim, Mead & White (New York), the Agricultural building; George B. Post (New York), the Manufactures building; Van Brunt & Howe (Kansas City), the Electricity building.

To this list was afterwards added Charles B. Atwood, chief of the department of design in the office of the director of works, who designed the Peristyle, which separated the east side of the Court from the Lake by an open architectural screen, and the Terminal building, which enclosed the Court on the westward or landward side. The subsequent enlargement of the Court toward the west finally included the Mines building, so that its architect, S. S. Beman of Chicago, became practically a member of this especial division of the architectural board. Adler & Sullivan, architects of the Transportation building; Jenney & Mundie of the Horticultural building; Burling & Whitehouse, of the Festival Hall; and Henry Ives Cobb, of the Fisheries building, all of Chicago, were also members of the board; but their work, being outside the Court of Honor, and placed in that part of the park where the internal water-system had been

released from the artificial restrictions of the formal canals and suffered to expatiate capriciously in the broad lagoon, was, in sympathy with the changed topographical conditions, invited to assume a free and more romantic character. The architects of the Transportation and Fisheries buildings frankly availed themselves of this opportunity and, in a manner entirely American, showed that they could be unconventional without license, archæological without pedantry, and independent without caprice.

The members of the general architectural board met for the first time in Chicago on January 10, 1891, and the final general tentative plan of the grounds with the proposed locations of the greater buildings, which had been in course of preparation for several months by the firm of Frederick Law Olmsted & Co., landscape architects, of Brookline, Mass., assisted by the late John W. Root, of the firm of Burnham & Root, architects, of Chicago, was submitted to them for criticism. A week's careful discussion of this preliminary scheme, during which numerous modifications, more or less important, were successively considered and laid aside, resulted practically in its adoption. To each member of the board of architects was assigned a building, and the architects who had in charge those surrounding the Court of Honor, early impressed by the vast importance of formulating a general scheme of design of such a character as to secure a monumental expression of unity without unnecessary interference with the development of a characteristic individuality in each building, agreed upon four conditions: (1) that the general form or style should be strictly classic in the best academical sense, a style intelligible to the world and one developed from the highest conditions of civilization in history,—a style, in short, which, though based upon accepted formulæ, had proved itself capable of an infinite variety of expression; (2) that the columniated order, which each might wish to use, should be proportioned to a common height of sixty feet from the terrace to the top of the cornice; (3) that the module or limit of dimensions in the plan should not essentially vary from twenty-five feet; and (4) in order to provide for a circulation under cover around the court so far as possible, that an open ambulatory or continuous portico should be incorporated as an essential part of each design at least on the court frontages, this ambulatory being practically continuous with the general level of the main terrace surrounding the great basin and canals.

As a further precaution in the interest of unity, each architect of

the Court voluntarily submitted his preliminary design to his brethren for their criticism, and removed or modified, in a spirit of mutual conciliation, any feature which was found in any way to injure his neighbors by contrast, or seemed to introduce a note of discord in that majestic symphony of architecture which at once began to take definite shape in the mind of each one as an ideal to be realized at whatever cost of individual preference. If, in the history of art, such a contract had ever before been made, never before had it been so loyally and conscientiously observed. The ideals which, by the study of imagination, are created by the artist out of the most refined elements of his own spirit, are so delicately adjusted, so jealously protected, and nourished with such sensitive care that they can hardly be criticised or questioned by any one without giving pain. The pages of Vasari and Milizia, therefore, are full of quarrels of painters, sculptors, and architects; their biographies bristle with combats of words or swords. But in the great arena of the World's Columbian Exposition, where so many professional interests were vitally at stake, where the atmosphere for many months was so highly charged with artistic endeavor, nothing from first to last was written, spoken, or, so far as I know, thought of to break for a moment that fraternal peace, that harmonious and prolific coöperation, out of which alone a great and memorable architectural achievement could arise. This ordered collaboration was to each of the architects of the Court the most exciting and interesting experience of his professional life, though each one, for the common cause, was constrained to yield some feature which seemed more or less essential to the complete presentation of his design. But if these details were cheerfully abandoned, there were compensations in the suggestive criticisms of his brethren. Under these circumstances the standard of composition was maintained at a high uniform level and the friendly emulation inspired each one to his best endeavor. This coöperation was indeed in itself a Court of Honor, before which the professional resources of each member were brought to perilous trial in a judgment of peers. Each design was measured by its best capacities and was compelled in the direction of technical perfection. To this end the stipulated constraints of mutual conformity in general character for the supreme sake of unity, in themselves, encouraged a finer study of those points of detail which worked for the expression of individual character. The classic formulæ of the order which, in the history of the Renaissance, instead of creat-

ing a universal cosmopolitan type, had proved themselves elastic to the expression of the genius of races and nations in the curiously distinctive variations of the Italian, the early and late French, the German, the English, and the Spanish Renaissance, were once again, in this great experiment in America, differentiated according to the personal equation of each of the five architects of the Court. In none of the buildings was any attempt made to capriciously vary the accepted orders of architecture which were adopted in each, or to modify their proportions or details as established by the studies of the greatest masters during four centuries; but each architect, in the development of his theme, so adapted these orders to his especial conception as to create a composition which was distinctive without losing its proper relationship with the rest. For these orders, so perfected by usage, so enlarged by their application to the service of art through centuries of experience, constitute a language of form more copious to the expression of architectural thought than has as yet been developed in our experiments with any other archæological, or with any merely picturesque or romantic, systems of decorated structure in existence.

A brief analysis of each building of the Court will show how the principle of personal independance operated in developing the component elements of that great Unity, which made the official architecture of the Exposition memorable in the history of art.

The pavilion of Administration was intended to be officially and architecturally the most conspicuous structure of the Exposition. It was accordingly placed at the intersection of the most important axial lines on the general plan of the grounds; it closed the most important and the most numerous vistas, and was in short the great central monument and the culmination of the largest group of buildings. But its area upon the ground was very much smaller than the smallest of the structures. Its necessary predominance therefore could only be obtained by superiority of height. This was so evidently an essential point of the general architectural scheme, that all the other buildings of the great court were subordinated to it in this respect. In contrast they expressed their dignity by vast horizontal extensions and avoided every feature which might compete with this distinctive characteristic of the principal structure, which therefore easily assumed the form of an octagonal hall or rotunda of heroic dimensions, with a domical ceiling, expressed externally in a lofty dome, the hall being buttressed by four wings on the alternate sides, giving, internally,

accommodation to the various complicated services of administration, and, externally, assisting in securing the pyramidal outline necessary in every monumental composition. The form of classic art preferred by Mr. Hunt in this great monument was that developed into a national style by the French builders since the sixteenth century. It was the style inculcated by the Ecole des Beaux-Arts of Paris and practiced in the best art of that nation.

On the other hand, the classic dialect used in expressing the architectural thought of Machinery Hall, or the Palace of Mechanic Arts, was rather archæological than scholastic, and appropriately recalled that developed from the civilization of the land of Ferdinand and Isabella, and Columbus. The accent of the wall treatment behind the great colonnade of the second story was distinctly Spanish, and the somewhat free and romantic spirit of that national school gave character also to the spires, which flanked the main central porches on the north and east, and to the flattened domes of the corner pavilions. But the mass of the building was corrected and its detail refined by the scholarly application of high academical principles.

The architecture of the Agricultural building was expressed in the purest and most elegant form of the original classic of antique Rome, such as appeared in the imperial palaces and baths of the best period. But the design, which, in itself, will always be remembered by students as an example of complicated but perfectly balanced symmetry, was adjusted to its special purpose and completed as an architectural composition of the first rank by a splendid profusion of sculpture and painting, expressing in poetic allegory all the pastoral and bucolic illustrations necessary to show that this imperial structure was dedicated, not to luxury, but to the manifold industries of the soil.

The same historical forms were echoed at the east and west ends of the vast quadrangle. No art less sumptuous than that of the Augustan era could have foreshadowed the magnificent double Corinthian ordonnance of the open Peristyle between the Court and the Lake, the triumphal arch of its central water-gate, and the two pavilions which extended as wings from either extremity toward the Court, supporting by their massive solidity the open architectural screen between. The art of modern times, though it has often expressed it on paper in the theses of the schools, has never given palpable shape to an architectural dream at once so pure, so majestic in scale, and so sumptuous in detail. That a

composition so poetic, and answering no possible requirement of common sense or practical necessity, could have been executed in an age of Philistinism, and in the most modern of all the great cities of the world, proves that materialism and science have not taken undisputed possession of our civilization and that we are still ready, when necessary, to sacrifice to the spirit of pure beauty.

The same high spirit made possible the other architectural screen, which, enclosing the court of the obelisk on the south, carried the orders of the two stories of the Machinery building across to make connection with those of Agriculture, its opposite neighbor.

On the north side of the great Court the enormous curved roof of the Manufactures and Liberal Arts building, covering with its unprecedented span an area as large as the Court itself, arose like a mountain high above a comparatively low enveloping mask of architecture, composed of an arcade of windows, vanishing in the distance in endless perspective, without any other incident to break the dignity of its infinite monotony than that furnished in the center of each front and at the corners by vast porches of entrance. The arcade was expressed in the somewhat sophisticated, but always elegant, Renaissance used by the French artists in their last Expositition, but the porches followed the insolent grandeur of the triumphal arches of Rome, thus boldly uniting in one design the first and last expressions of classic art, twenty centuries apart.

On the same side of the Court as this vast palace of the Liberal Arts, the canal forming a street of water between, arose a structure the elements of which were in the conventional Italian Renaissance of Vignola. But the long stretches of horizontal lines in cornice and string courses, which were the distinguishing characteristic of all the other buildings, here were subordinated to a rhythmic repetition of frequent vertical lines breaking through the cornice, and attacking the sky with a series of ten lofty campaniles and four domes, the total effect being as fantastic, as full of sudden movement and vivacity, as the conditions of conformity would permit. The distinctive character of this stately pleasure house was devised to afford an appropriate shrine for the genius of the most mysterious and most restless of the elements of nature, Electricity, hardly yet broken to the harness of industrial art. The suggestions for this use of the classic formula were largely obtained from the French Renaissance of the sixteenth century, as expressed in the royal Château of Chambord

The Mines building, completing the northward closure of the Court of Honor, presented still another variation of the Roman formula. It was to accommodate a collection of comparatively coarse machinery and appliances, with crude and manufactured products of the mine. The architect consequently did not dream of making a palace of his building, but, taking a larger unit of dimension than the rest, he indicated in terms of architecture the character of his exhibit by a structure much more massive, suggesting nothing of a domestic or even civic purpose. The result was necessarily and properly a building of industrial character, purified and refined by its application to an occasion of national festival, simple, large in its parts, using in its decoration *motifs* from many classic precedents and amalgamating them in such a manner as to show how an intelligent American should adapt his inheritance of ancient and historic forms to uses never foreshadowed in the civilization of the past.

The Terminal building at the west or landward side of the great Court, like the great central hall of the Roman baths, needed large and frequent openings for ingress and egress on all sides. The Roman precedent was therefore frankly adjusted to this new service with large and noble effect.

The work of reconciling variety with unity in this great group of buildings was further illustrated and made effective by the observance of common axes, and by the correspondence of opposite pavilions and water-stairs in neighboring buildings, in the service of unity, and by the contrasts in these correspondences, in the services of variety, affording in every vista at once a stately expression of ceremonious and symmetrical order and a continual play of oppositions having all the best effects of the romantic and picturesque. In the accidental aspects of the group, domes, towers, and spires, each devised to emphasize and illustrate a problem of symmetry, combined themselves in endless surprises of perspective, which were all the more pleasing because not intended and therefore not insincere, artificial, or theatrical. To these unpremeditated results of art the innumerable accessories of landscape and water effects, the balustraded terraces, the bridges, and landing-places, the monumental fountains, vases, and groups of statuary, the kiosques and rostral columns, the banners and gonfalons, the moving pageant of gondolas and launches, the costumes and groupings of the multitude, the strains of music, the glimpses of decorative painting in the porches,—all these added an infinite foreground of movement,

color, and incident, which completed this memorable conquest of art over the combined forces of ignorance, vulgarity, and commonplace,—this triumph of sentiment over materialism and Philistinism in all its forms.

It has seemed to me best, in an essay so brief as this must be, to confine myself to that part of the demonstration of architecture at Jackson Park which seemed to make the deepest impression upon the public, and which by reason of the unity of its conception seemed best capable of literary exposition. If I had attempted to include in this brief analysis the other official buildings and the almost innumerable representative structures created by foreign governments, by the States of the Union, and by private companies upon these grounds, I should have far exceeded my limits. It may be worth while, however, to state that from a professional point of view, there has never been brought together in one place an illustration so complete and so imposing of the power of architecture, not only to represent the distinctive development of races and nations in the course of empire, and the history of humanity from savagery to civilization, but to elevate and enlarge the mind while delighting the imagination. But, as no organized attempt was made outside of the Court of Honor to establish any effective unity among these buildings, the cumulative effect of their architecture was lost; each structure had to maintain its individuality in the presence of many conflicting elements,—not only without the friendly support, but often against the positive opposition of its neighbors. The result was that in the northern parts of the park we had, not a concert of many divergent but harmonious arts, but rather a museum of heterogeneous forms, in some places illiterate and poor, in others merely curious, but for the most part admirably expressive of some characteristic phase of historical art.

Above this confusion of tongues one clear lucid note of harmony arose, prevailing and sweet, in the pure and serious Greek architecture of the galleries of Fine Arts, around which these insubordinate buildings were grouped. It was an element of conciliation potent enough to restore to the bewildered mind of the beholder the peace and rest of true art.

The soul into which at least some part of the architecture of the great Exposition did not enter as an illumination never to be extinguished, could not be touched by any manifestation of beauty. The White City suddenly advanced the standard of modern civilization, and obliterated forever whatever trails of provincialism

lingered to retard the progress of our country. It made the crudest communities of the frontier hospitable to nobler and purer forms of art, and showed once for all a practicable way by which every street and square, every boulevard and avenue of our new cities may, even when composed of the simplest and most modest elements, be made beautiful by coöperation. If order is Heaven's first law, the City of the Blest is prepared for the abode of the chosen ones by the happy harmony of the celestial builders.

ELECTRICITY IN 1876 AND IN 1893.

By Elihu Thomson.

OVER a hundred years ago Tiberius Cavallo wrote in his introduction to "A Complete Treatise on Electricity" as follows: "Discoveries crowded upon discoveries, improvements upon improvements, and the science ever since that time went on with so rapid a course and is now spreading so amazingly fast, that it seems as if the subject would be soon exhausted, and electricians arrive at an end of their researches; but, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps equally, or more important than those already made."

This was before the voltaic battery became known, before Davy experimented with it and produced the electric arc between carbon points, before metals were deposited in electrolysis, before the effects of electric currents on magnetism was discovered, before anything was known of the extensive fields of electro-magnetic and magneto-electric induction, before the telegraph, the telephone, the electric light, the electric motor, the electric railway, the art of electric metal-working, and indeed before everything which now marks electrical science as of such great importance in our time.

I have quoted the passage above as aptly expressing a thought which has doubtless in these later years arisen in many minds. It might well have been written in the present year of the World's Columbian Exposition in view of the exemplification there made of the great progress in electrical arts during the period since the Centennial, seventeen years ago. No similar period in the world's history has in any art shown so rapid development, so extensive and refined scientific study and experiment, so active invention, so varied application, such care and perfection in manufacture, as has taken place in the electrical field within the period mentioned.

It can be truly said that as a department of applied science and engineering, electricity has taken an important place only within the past ten or twelve years. I do not forget that before the Centennial we had the telegraphic engineer, with his knowledge of batteries, lines, relays, sounders, etc.,—a sufficient equipment for his work which was then the most important electrical application.

I do not neglect the cable engineer, with his more refined and delicate methods, due to the somewhat different conditions required to be met in the construction and operation of submarine lines. Electro-metallurgy, including electroplating and electrotyping, had already become of great utility when the Centennial year opened. But seventeen years ago there were no dynamos in regular operation for electric lighting in the country, although a few machines of the Gramme and Alliance types were used abroad. Special forms of dynamo machines had been designed for electro metallurgy, and a number of them were in use, but installed only a short time prior to 1876. Small magneto machines had been employed for a number of years previously as substitutes for primary batteries in exploding fuses for blasting and torpedo service. Electric motors, hardly worthy of the name, were here and there operated at great cost from primary batteries, but they were of insignificant power, and resembled the old designs which figured so largely in catalogues and collections of philosophical apparatus,—instructive enough in their way, but of no practical value.

What then was comprised in such electrical exhibits as were found at the Centennial Exhibition in Philadelphia? Living there, and working in the electrical field, I remember that I possessed a lively mental sense of the ultimate vast utility of electrical forces which caused me to employ the opportunities afforded for study of such exhibits as from a practical or scientific standpoint showed distinct advances. There were in the Main building a number of such exhibits as telegraphic apparatus and systems of signaling, electric clocks, burglar-alarms and the like. In the class of philosophical instruments were the usual electric models for educational purposes. Electric-key action was found applied to organs and automatic playing of the same. In Machinery Hall were to be found a few crude electric motors run by expensive and noisome primary batteries. Such motors were of but small power, and belonged to the old types, with electro-magnets and bar armatures successively attracted or repelled. The application of dynamo-electric machines to electroplating, then in itself quite a novelty, was represented by Weston machines of fair size. In these machines some of the principles of modern self exciting dynamos were found, but the armatures were of the old-style polar pattern with a single-winding terminating in the usual pair of plates called a commutator.

But we need not further concern ourselves with these exhibits.

They gave but small indication of the future of electrical progress. There was nothing in them to indicate or suggest that the world was on the eve of great advances so soon to be made.

There were, however, two exhibits in Machinery Hall of great interest to electricians as showing types of electrical machinery which in various modified forms were soon to work revolutions in lighting and transmission of power. These two exhibits were of the Gramme and Wallace machines. Neither was remarkable for floor space covered, but notwithstanding their modest extent, and the fact that they were sandwiched in between exhibits of entirely different class and widely separated one from the other, there was that in each of them which could not fail to be of deep interest to an electrical worker. The Gramme machine itself had become known in the United States through descriptions in scientific journals, and there had been two or three machines imported into the country. Two of these I had the opportunity of inspecting a year or two before. Another Gramme machine—built at Cornell University if I remember rightly—was sent as an exhibit to the Centennial Exhibition. This was probably the first dynamo of the kind built in the United States.

In the Gramme space itself could be seen a small belt-driven dynamo, giving current for the working of a single arc lamp in its circuit, series-working being unknown at that time. In this space also there was an arrangement of circuit whereby one machine driven by the belt as a generator, furnished current through some twenty or thirty feet of wire to a second similar machine, which then ran as a motor. This was in turn belted to a small centrifugal pump which produced a small cataract of water. Experiments were also made from time to time in the heating and melting of wires by the current generated by the machines on exhibition. Special coarsely-wound low-potential Gramme dynamos for electroplating were among the interesting features. I remember the feeling of admiration,—I might almost say exultation,—with which I viewed this most unique exhibit. I also remember the enthusiasm of the attendant, whose voice held firmly to its French, and musically rolled off the catalogue of the capabilities of the Gramme machine, "la lumière électrique, la galvanoplastie, le transport de force motrice, la telegraphie," etc.

I need not remind the technical reader that the Gramme machines were the first dynamos of the true modern type constructed —the armature iron being circular in outline and preserving its re-

lation to the magnetic field while rotating, and the winding thereon being continuous, with leads taken at intervals to a commutator of many segments. The result was a smooth unbroken current resembling that from batteries. While in these machines the core was a ring and the wire was wound over and through the same, the subsequently developed drum type differed from it only in the disposition of the closed armature winding all on the outside of the ring core instead of through its center.

The exhibit of Mr. William Wallace was unique in showing a number of different types or forms of dynamo, while the Gramme machines were substantially alike in pattern. The Wallace machines furnished current for single arc lamps, for plating baths, and were reversed and run as motors. This exhibit was very suggestive of types and forms which afterward came into general use, and fortunately the machines themselves were preserved and sent to the World's Fair in the present year, a retrospect as it were of the Centennial exhibit. Historically considered, such early models are now invaluable. Space does not permit any detailed reference to them. Some of them were used, as were the Gramme machines, for furnishing current to work large reflector lamps similar to search-lights, mounted on the roof of Machinery Hall, on occasions of evening celebration, with fireworks and other displays.

The Centennial will be remembered in the history of electrical progress on account of the fact that the telephone of Alexander Graham Bell became then for the first time known as an accomplished fact. It spoke with a small voice, it is true, at the Centennial exhibition, but the echo of that voice was heard over the civilized world. The telephone had been invented just in time to date its birth from 1876. Dr. Elisha Gray, who was close upon Bell in the invention of the telephone itself, was exhibiting his harmonic telegraph, a very ingenious multiple telegraph, but the chief interest soon centered on the instrument that could talk. With the advent of the speaking telephone there seemed to come about a general awakening to the capabilities of electricity in practical work. It prepared the public mind for the coming of new wonders. It attracted attention to other electrical enterprises and to a large extent wiped out the factor of conservatism in relation thereto. Indeed, the telephone had scarcely begun to be used practically before the announcement of the invention of the Jablochkoff candle drew attention to the field of electric lighting, and in 1878 the Avenue and Place de l'Opera, lighted by electric candles, constituted one of the

great achievements of the Paris Exposition year. The Jablochkoff candle did not, however, realize expectations; it was too costly, and soon gave place to ordinary arc lamps run in series. Much pioneer work in this field was done in this country by Mr. Charles F. Brush, of Cleveland, who in 1879 had as many as sixteen arc lamps running in series from one of his well-known dynamos. A few other inventors were almost equally early in this work.

It was toward the close of 1879 that Thomas A. Edison succeeded in accomplishing the task which he had undertaken and upon which he had been at work for a year or two. This was the invention of a small electric lamp giving a light of about the same candle-power as a gas-jet, and capable of being run in multiple with many others, without requiring too large a current or too frequent renewals of the lamp. Such a lamp to be commercially successful needed to be of low first cost, economical of power, and easily reproduced in large numbers. No one, unless he has been engaged in similar undertakings, can begin to realize the amount of effort, self-sacrifice and hard work which must have been required not only to perfect the lamp itself and the details of its manufacture, but to provide suitable generators, regulators, distributing systems, mains, safety-devices, and the other things which go to make complete the electrical equipment of a lighting installation, a revolution in lighting means and methods. That Mr. Edison and his able assistants undertook and accomplished this work, the records of the numerous inventions in this field would be sufficient evidence, did we not have the fact of the actual accomplishment as a matter of engineering history.

It would be beyond the scope of the present paper to trace the history of the innumerable developments in the electrical field brought about by the effort and genius of a great army of workers, both here and abroad, between the years 1876 and the present. It must not be forgotten either that, aside from the great engineering triumphs which are from their practical benefits sufficiently prominent, electrical science, purely as a science, has expanded and progressed apace.

The advance, though a rapid one, has been sufficiently gradual to allow us to note the process as more of evolution than revolution. The great exhibitions held within the period between 1876 and 1893 have embodied more and more electrical arts and productions. Add to these the specially electrical exhibitions,—as in Paris (1881), Philadelphia (1884), and Frankfort (1891),—and the

growth becomes evidently a gradual unfolding. It was natural, then, not only that the World's Fair of this year should have been characterized by progress in all arts, but that it should have become more distinctively electrical than any preceding international display. It is to be doubted, however, if many were prepared to find that such dependence on the work of the electrical engineer would be shown.

Whether we regard the lighting of the vast areas and spaces in and around the great structures in Jackson Park, or the transportation by rail or water within its boundaries, or the distribution of power for various purposes, it was through the agency of electricity that these objects were attained. In fact, the great bulk of the steam-power developed was to give motion to the dynamos for furnishing current for all the various uses to which, in these days, electricity has been applied. It is certainly no exaggeration to say that the vast amount of mechanical power developed and used at the World's Fair was mostly used for electrical purposes or transmitted electrically for its ultimate use. A vast area in the Mechanic Arts building, covered with engines and dynamos driven thereby, directly adjoined the boiler-houses and formed for the time, as it were, the most gigantic electric station ever installed. From it was sent out current for several thousands of arc-lights, for from 50,000 to 100,000 incandescent lights, for innumerable electric motors working elevators, driving machinery of all kinds, ventilating, for charging storage-batteries, for electric-welding, forging, heating, and other uses.

At the Centennial in 1876 no perceptible fraction of the power was electrically used. At the World's Fair it had become almost wholly electrical. The arrangement of the great Corliss engine at the Centennial was in the middle of the Machinery building, and by a complex system of gears and belts the power was transmitted and delivered to the long lines of shafting extending each way from this central power source. This was a limitation of service arising directly out of the absence of electrical transmission. At the World's Fair, on the other hand, power could be delivered anywhere by the use of electric motors and the moving machinery was not therefore practically restricted to a building in which a steam-engine was at hand.

In 1876 arc-lights were a curiosity and but rarely seen. In 1893 their use for illumination of streets and large spaces is almost universal. Never has there been, however, any greater display of arc-

lighting than in the present year at the World's Fair. The whole of Jackson Park was dotted over with these miniature suns at night and the interiors lighted. Under the roof of the Manufactures and Liberal Arts building were five large coronas comprising many arc lamps each, a unique display in itself and an economical arrangement as well. About 2000 arc-lights, if I mistake not, were employed in lighting the gigantic structure throughout. The great search-lights, with their 60-inch mirrors reflecting the light from specially large arcs in their foci, were a striking feature of the illuminations, and these artificial sunbeams were of an intensity never before approached.

The whole art of lighting by electric incandescence has come into existence since 1876. Incandescent lamps can now be made of such uniformity of voltage and energy consumption as even to dispense with any need of photometric measurement, and indeed to require no testing or sorting after manufacture. Such lamps may consume about $3\frac{1}{2}$ watts per candle and have a useful economical life of over a thousand hours of service. An achievement like this means attention to many small details, and the doing of delicate work on a large scale. Astonishing it is to find that frequently in such work, what was formerly a delicate laboratory manipulation becomes every-day work-room practice; and here constant practice of delicate operations by even ordinary labor results finally in almost perfection.

The larger part of the incandescent lighting of the World's Fair—and the little bulbs were everywhere used and useful—was carried out on the alternating-current plan so commonly employed in cities and towns where the electric station must be at a considerable distance from the mass of consumers. Huge dynamos in the Mechanic Arts building supplied the alternating current at high-pressure in mains leading to the transformers, located in receptacles in the ground, from the secondary circuits of which the low-pressure currents were fed to the lamps connected thereto.

At the time of the Centennial, alternating currents were known, —and dynamos yielding such currents were known, being among the earliest invented,—but the transformer was unknown. The nearest approach to it was the induction coil for shocks or medical use and the Ruhmkorff coil. Soon after the invention of the telephone, however, the induction coil, modified and used in conjunction with carbon transmitters, enormously increased the distance over which speech could be successfully transmitted, and has led in

1893 to the regular communication by telephone over distances more than a thousand miles, while such is the delicacy and fidelity of transmission that it is not necessary to speak much above a whisper at New York or Boston to be heard in the receiver at Chicago.

The transformer or modified induction coil has in like manner rendered possible the economical transmission of electric energy to great distances, as the working of low-voltage incandescent lamps at miles of distance from the supply station. Otherwise the line losses and excessive cost of mains would in such cases forbid the use of direct supply. The perfection to which this useful apparatus, the transformer, has been brought by careful work may be judged from the fact that it often has an efficiency between 97 and 98 per cent. at full load. It is a simple affair of copper wire and sheet-iron, apparently, but it has required much study and experiment to bring it to the present state of perfection. There is little or no opportunity for further advance. The very great expansion of incandescent lighting both by the direct supply systems and transformer systems during late years is sure to continue at an increasing rate in the future until it includes a large proportion of the lighting done in cities and towns.

In 1876 the storage-battery was practically unknown. A crude form devised by Planté had been experimented with for a considerable time before, in the laboratory. The eminently successful use made of the electric launches on the lagoons at the World's Fair was an ample demonstration that in the past few years a new field for electrical work had been opened up. The application of the battery to boats is of course but one of the uses for the modern storage-cell. Many electric stations in Europe and a few in the United States have within late years added an equipment of batteries, to work in conjunction with their dynamos in giving out current energy when the consumption is heavy, and to absorb energy or become charged from such machines when the consumption is small. This in a large measure prevents overloading at one time or the running of the machinery with loads too light to be economical at other times. How far experience will confirm the apparent advantage of such a plan remains to be seen.

The largest single exhibit of an electrical nature, was without doubt the Intramural railway and its power-house,—together a grand practical exemplification of electricity applied to traction. It was remarkable in many ways as a piece of engineering and op-

erated with the greatest success. It emphasized the fact that the days of steam locomotives on elevated roads in cities are numbered, and that just as surely as the horse-car has given place to the trolley-car, so must the electric motor supplant steam propulsion on the roads in question. Yet in 1876 there was no hint or suggestion of such extended use of electricity on railways—and, in fact, no such applications had been made. On the Intramural road a conductor rail with the ordinary rails for return circuit was used, the current being taken up by sliding shoes bearing on the conductor rail. The motor-car at the head of each train, besides the ordinary seats, was provided with four electric motors, one geared to each axle individually, while the controlling mechanism was arranged so as to connect the motors in single series for starting and to make successive changes passing through intermediate connections until the one having all the motors in parallel was reached, the condition for maximum speed.

This arrangement, with refinements of detail especially designed for this work, and first put into full operation at the World's Fair, gave great economy as well as flexibility in the handling of the trains. One of the best illustrations of the progress in the art of electrical engineering in the past few years was the building in the station of the Intramural road of the great direct-coupled continuous current dynamo of 2000 horse-power capacity. This machine—by far the largest continuous current dynamo ever made—was lately described by its designer, Mr. Horace F. Parshall, in this Magazine (September, 1893). It is a comparatively simple undertaking to design and construct very large alternating current generators, since in many respects they are like duplications or enlargements, simply, of the elements of smaller similar machines. This is not so with continuous current types, as the problems of armature reaction, air gap, and self-induction as affecting the working of the commutator at various loads have to be carefully estimated, while the relation of turns on the armature to number of segments in the commutator, the proper proportions and construction of the commutator itself, and the other proportions, have to be studied with great care and adjusted within limits. All this makes the production of so large a machine, built as it was without previous experiment, and its parts put together even to the assembling of the sheet-iron pieces of the armature, in the station itself, a veritable triumph of engineering skill.

Speaking generally, it is not far from the truth to say that at

the World's Fair there was as much to be seen of electrical application outside of the Electricity building as within its walls, though this building was itself a temple of electricity. There were, it is true, a number of exhibits of no special significance, such as those of shifting light in masses of incandescent lamps, obtained by complicated switching appliances, colored lamps being freely used. The most artistic display of the kind was the Edison tower of lights, a creditable piece of work, the effects obtained from which were certainly very striking and beautiful. The large and varied display of modern electrical apparatus and machinery, together with the various historical exhibits were of deep interest to the student or engineer. There were found a fully equipped-modern telephone exchange and also Dr. Gray's "telautograph," which is in a certain sense an intended rival of the telephone. There also were found many types of dynamos of various makers both here and abroad. Electric motors were found applied to all manner of work,—pumps, hoists, elevators, locomotives, and mining-machinery generally. Electric arc lamps and machines, carbons, of all leading makers, were here together with exhibits showing many forms and patterns of incandescent lamp, lamps of low voltage to lamps of high voltage, lamps with one filament to lamps with a dozen filaments, lamps of one candle power to lamps of hundreds of candle-power, etc. There were full lighthouse equipments with their huge compound lenses on view. On the one hand was to be found appliances for generating electricity of enormously high pressures, such as would leap in torrents of sparks over more than five feet of clear air space, and on the other hand apparatus for electric welding and metal-working capable of yielding currents of 50,000 amperès with pressures as low as two or three volts. The comprehensive exhibit of practical work done in electric welding, including the largest weld ever made by electricity, in which the section at the weld was forty-eight inches of steel, was of great interest to many practical men.

A number of creditable exhibits of alternating-current motors of such types as single-phase, diphase, and triphase construction were found, so that the respective characteristics of this most interesting of the recently developed forms of alternating current apparatus could be examined. This class of electric machinery is of so recent production that we must look to the future for its wide application. Everywhere in Electricity building was evidence of enormous growth of electrical industries. It could be partly

understood from the variety of such things as switches, safety cut-offs, wires, cables, insulating materials, found there, aside from the heavy machinery.

In the department of measuring-instruments alone, the progress to be noted was remarkable. Ammeters, voltmeters, wattmeters, recording wattmeters, standard resistances, standard cells, electrical balances and bridges, of the highest degree of excellence, were not wanting. With the refined means of measurement so provided the estimation of electrical forces and quantities may be made with a rapidity and precision hardly equalled in any other department of physical science. Enough has been said, however, to indicate what a harvest has, in the past few years, been the outcome of the earnest effort of brain and hand in the electrical field.

The one discordant note in all this great display of genuine scientific and engineering work was found in the fact that in this same temple of science,—in Electricity building itself,—naked imposture, quackery in the form of so-called electric belts, hair-brushes, insoles, and what not, had obtained a footing and stalked forth unabashed. No words of condemnation can be too strong to be applied to the parasites, who in the guise of healing and benefaction, succeed in extracting perhaps the last money from the sick and suffering for their worthless trumpery. The fact that such exhibits were found in 1893 holding place alongside of genuine electro-therapeutic appliances of undoubted merit only heightened by contrast the great shame of their presence.

Within the limits of the present article it has manifestly not been possible to do more than briefly refer to such electrical features of the World's Fair as show in concrete form the great advances which have taken place since the Centennial year.

Our technical schools and universities now devote to the teaching of electricity as a branch of engineering special courses, special laboratories, special instructors. Formerly the little electrical knowledge taught was taken up as a department of physics.

In this present year, the arc lamps in use are numbered by the hundred thousand, incandescent lamps by the million, while millions of passengers are carried daily on electric cars, thousands of horse-power transmitted and distributed by electric motors, thousands of tons of metal refined annually by electrolysis, chemical decomposition on the large scale effected, as in the production of cheap aluminum, electric furnaces are turning out their special products, such as carborundum of diamond like hardness, and

electric-welding and metal-working machines are in active service in a large number of manufactures.

In summing up this great growth we must not forget the enormous extension of telephone-service systems in the past few years. So great have been the advances that it is natural to expect that in the immediate future similar rapid and important work will be undertaken and accomplished. It is difficult to play the role of a prophet unless the prophecies be made so numerous that some of them cannot fail of realization. There are, however, some things concerning future electrical development about which we can be positive. It is not likely that, except in details, much advance will be made in dynamos and motors. The efficiency of well-designed types is now so high as to leave very small opportunity for improvement. Large dynamos at full load have commercial efficiencies ranging from 95 to 97 per cent. Transforming apparatus of various types may readily have at full load a net efficiency of 97 per cent. The possible efficiency of arc lamps is about reached—and with the incandescent lamp the volatility of carbon at high temperatures governs the efficiency and life. The higher the temperature the more efficient the lamp, the more volatile the carbon of the filament, and the less will be the life of the lamp. It is unlikely that any better material than carbon will be found for the filament, and the properties of carbon as to volatility can probably not be changed.

The cost of these lamps is now about as low as is consistent with good quality and uniformity. The use of transformers for raising or lowering the line potential, permits long-distance transmission of electric energy with moderate loss. The conditions of the most efficient use and operation of electric motors as a source of power when transmitted, have been well worked out, so as to leave but little further to be accomplished in that line.

We can hardly expect, therefore, to make any radical gain in the operation of electric plant unless by the utilization of new principles in unexplored fields. A substantial gain in the economy of the development of power from fuel is of much greater moment than any possible gain in the efficiency of the electric plant. Hence electricians are looking for cheaper power, as that and that alone now means cheap electricity. For the same reason attention is more than ever concentrated on the utilization of water-power, as of Niagara itself by the Cataract Construction Company. Much future work will be done in this field, and it will give rise to many

new problems for solution by the electrical engineer. The laboratory work of to-day becomes engineering work of to-morrow. Work which to-day is in the experimental stage reaches its full commercial completeness only after considerable practice with it under varying conditions. The advance work goes steadily on, but in channels which demand more and more intricate knowledge of electric actions. It is the fervent hope of many an electrician that, at no very distant time, the energy of fuel may be converted more directly into electric energy, and without the enormous percentage of loss that is involved in present methods, and that some means may be found to further transmute the electric energy into light with but a small percentage of dark heat, instead of present wasteful methods; but this is still a hope only, and there is not even a probable solution indicated.

In the department of electrical engineering work, the early future will I think witness, in addition to a constantly-increasing use of electricity for illumination, further application to chemical and metallurgical work. The field for the application of electricity to mining, for hoists, for pumping, drilling, mine-haulage, and the like, is very wide. While it is not probable that the steam locomotive for long distance railroading will soon be supplanted by electric locomotives, still there is a growing interest in these latter as applicable to special cases, such as specially-designed high-speed roads between populous centers, for tunnel work and elevated roads in cities. As feeders for trunk-lines of railroad it would seem that trolley lines are admirably adapted both for passenger and freight service, and their employment in this way will doubtless become of great importance in densely peopled localities.

There is also a field for the application of electricity stored in batteries to propulsion of road vehicles, a field in which but little has hitherto been done. Electricity generated under present conditions, involving in the first conversion into mechanical power such an enormous loss of heat energy of the fuel, will evidently not be applied as a general heating agent. In certain cases, in which the disadvantage of high cost may be outweighed by superior advantages of application, as in cooking by electric heat, there may result a considerable extension of its usefulness. But that it can be economically applied simply to heat metal bars for forging in a drop-press or rolling-machine, is not at all to be expected. In special cases of distinctly local heating of metal for welding, bending, or other process, it is now not only used with success and

economy, but it would appear that many additional applications of this kind will be made in the future.

While it may be reasonable to look forward to the ability to telephone through an ocean cable under the Atlantic, it is hardly likely that we shall travel over it in ships propelled by electricity. It would indeed be possible to construct electric motors able to turn screws and propel our largest ships, but the supply of current energy to them at the rate of ten to twenty thousand horse-power, for five days continuously, would require a storage battery to be carried such as would be enormously costly and so heavy that it could not be placed aboard without sinking the ship. It should, however, be borne constantly in mind, in dealing with the subject of electrical applications, that a new discovery might at any time change the aspect of every prophecy based on present knowledge and conditions.

AN ERA OF MECHANICAL TRIUMPHS.

By Robert H. Thurston, LL.D.,

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THE World's Columbian Exposition, were this the heroic age, would be the source of a new race of demigods. In those ancient days, according to Lord Bacon: "Fathers of their Country, and other eminent Persons in Civil Merit, were honour'd with the title of *Worthies* only, or *Demi-Gods;* such as were *Theseus, Minos, Romulus* and the like: on the other side, such as were *Inventors and Authors of new Arts, and such as endowed man's life with new Commodities, and accessions, were ever consecrated among the Greater and Entire Gods;* which happened to *Ceres, Bacchus, Mercury, Apollo,* and others, which, indeed, was done justly and upon sound judgement: For the *merits of the former* are commonly confined within the circle of an Age, or a Nation, and are not unlike seasonable and favouring showers, which though they be profitable and desirable, yet serve but for that season only wherein they fall, and for a Latitude of ground which they water; *but the benefices of the latter,* like the influences of the Sun, and the heavenly bodies, are for time, permanent, for place, universal: those again are commonly mixt with strife and perturbation; but these have the true character of Divine presence, and come in *Aura leni* without noise or agitation."*

The great Exposition was a grand cyclopedia of the arts and sciences, and a magnificent monument to the genius of the men who made it, and to the inventors and authors of new arts who made it possible. The ancients would have erected in its midst shrines to the deified inventors of the steam-engine, the railway, the steamboat, the telegraph, the telephone, the electric light, electric machinery for transmission of power, and of the tools of modern times, as well as to the inventors of the loom and of the older arts. But, at Chicago, the product of the inventive genius and of the originator of new arts was made shrine as well as monument; and all the world went there to admire, if not to worship, the material evidences of the culmination of an era of triumphs in every department of invention, construction, and engineering achievement.

* Bacon: Lib. I.; Cap. VII.

The nineteenth century probably will always be remembered, however long the world may last and whatever may prove to be its future progress in mechanics and the useful arts, as having been the century in which the long dormant genius of invention was awakened into life and full activity. This century has seen the grandest triumphs of every department of material growth and advancement. The steam-engine, little known and hardly appreciated as a possible burden-bearer for the race, has come to carry the whole weight, practically, of modern civilization. It does the work of a thousand millions of laborers, three or four times the working force of the world; it transports a thousand tons a thousand miles, in the modern steamship, at the cost of fifteen tons of fuel; it carries the whole commissary supply of the family of a citizen of New England from the cities of Chicago, Minneapolis, Kansas City, or St. Louis at a cost of about $10 annually; it consumes a pound or two of fuel and utilizes the dormant energy thus awakened in every direction in which its aid is desired, in the performance of the full day's work of an able-bodied man. The electric current, formerly mysterious, awe-inspiring, and only destructive, where its effects became visible, has been reduced to service, and not only now acts as a courier transmitting messages across continents and under oceans, or bringing friends a thousand miles apart ear to ear, but has become the right arm of the steam-giant and applies the power of the engine to the performance of work miles from the prime motor, sets the locomotive aside, and drives the train with a thread of wire. Machinery has entered into every department of human labor, and has not only relieved the workman from labor, but enabled him to produce an enormously greater product of vastly greater excellence. The whole great Exposition, with its hundreds of acres of marvels of science and of art, was the product of what has come to be an age of machinery, in which the genius of invention has become triumphant in every department of human endeavor. To walk from the Dahomey or the Javanese village to the Liberal Arts, the Transportation, or the Machinery building, was to pass from the age of primitive man to that of the man of the nineteenth century. To go from the Street of Cairo to the Court of Honor was to pass the ages in review.

The practical outcome of this revolution of a century has been the promotion of the welfare and comfort of the whole world, the elevation of races to higher planes of life, the advancement, not only of the material interest of the world, but also the intellectual

and the moral life of its people. With relief from the necessity of daily and incessant drudgery comes the power of devoting a part of life to thought, to self-improvement, to enjoyment of the comforts and of the luxuries, physical, intellectual and moral, which the new life offers. It will be interesting to note what have been the material results of this era of mechanical triumph, in which all the powers of nature have been reduced to the service of man, and in which the "art preservative of all arts" and its instrument, the printing-press, one of the most wonderful of the triumphs of invention, have given permanence and universal distribution to this extraordinary advancement.

As we look back over the single generation just ended, or back, we will say, to the beginning of the present half-century, it is easy to see that, as every economist has observed, this reduction of the forces of nature to service in the arts has, within the short period referred to, enormously increased the world's capacity for production in every field of industry. It has given the average citizen the means of securing an enormously increased proportion of the necessaries, of the comforts, and even of the luxuries, of life, as they would have been termed at the commencement of this period. Various writers estimate this gain at from 30 to 50 per cent., or more. At the prices to-day current, in many cases, the workman secures by a day's labor double the amount of food and clothing that he could have obtained then, and in many other cases he is able to procure what the wealthiest could not have obtained at any price a generation or two earlier.* Costs of transportation are re-

* Professor R. P. Falkner, analyzing the costs of products and the wage-lists of a half-century, gives the following figures for each, the tables here given being condensed from his more extensive report. The prices of 1860 are made the standard:

Year.	All articles averaged.	Year.	All articles averaged.
1840	116.8	1870	142.3
1845	102.8	1875	127.6
1850	102.3	1880	106 9
1855	113.1	1885	93.0
1860	100.0	1890	92.3
1865	216.8		

The following table shows the relative advance in wages in gold values for fifty years, taking 1860 as the base line. Relative wages in all occupations, 1840–91:

Year.	Average.	Wages Cost.	Year.	Average.	Wages Cost.
1840	87.7	$0.75	1870	133.7	$0.91
1845	86.8	0.84	1875	140.8	1.10
1850	92 7	0.90	1880	141.5	1.32
1855	98.0	0.87	1885	150.7	1.62
1860	100.0	1.00	1890	158 9	1.72
1865	66.2	0.37			

duced both by reduction in costs of steamships and locomotives and by diminished costs of operation. The iron steamships of to-day, as built by the great constructors of the Clyde, the Mersey, and the Tyne, cost $35 per ton, where they cost $100 in the earlier days of iron-ship building. As Mr. Wells has remarked, a 3000-ton ship twenty-five years ago might have required 2200 tons of coal to transport 800 tons of freight, while to-day the same class of steamer will carry 2200 tons of freight with 800 tons of coal. Provisions are carried from New York to Liverpool, in some cases, at a half-cent per pound, and grain in bulk at three to five cents a bushel. Our great railways carry their freight often at the rate of a half-cent per ton per mile, and still make a profit. Thanks to James Watt, George Stephenson, and their successors, the United States now have 175,000 miles of railways, and our millions of square miles are interlaced with a network of these arteries of commerce.

The consumption of iron and steel is one of the best gages of progress and of the condition of a nation. The United States, now the greatest producer of the world, makes 10,000,000 tons a year, of which about one-half is made into steel, and consumes all this and still imports more from abroad. This is above 300 pounds for every inhabitant, the largest consumption, in proportion to population, of any nation on the globe. This places us in the front rank among nations, thanks to Dudley and Cort, and Bessemer and Holley, who made all this possible by their inventions, and to men like Jones and Forsythe who systematized and reduced to most perfect method the processes of the furnace and the mill, making the cost one-half what it was a few years ago, in fuel, and a small fraction, one-fifth, in dollars and cents.

Production of clothing has similarly increased in quantity and diminished in costs. According to Mr. Norcross, the increase in the boot and shoe business has been, in the last forty years, about 400 per cent., consequent upon the application of the genius of the inventor and the skill of the mechanic to the construction of largely automatic machinery. No one goes barefoot to-day, except from choice. Only the wealthy wore shoes, habitually, a few generations ago. In Dakota the labor of one man, reinforced by the power of horses and of steam, and supplemented by the inventions of McCormick and his fellows, the makers of the reaping-machine, produces between 5000 and 6000 bushels of wheat ; and this, according to Mr. Wells, is converted into a thousand barrels of flour by the

labor of another man for the period of one year; while the labor of two more men deposits this flour on the dock at New York, and it is sent to Europe to compete in the market with the product of the cheapest labor and most productive soils of Africa and of India. In the times of Adam Smith, a century ago, ten persons made 48,000 pins in a day. A hundred years later, seventy machines, with three men in attendance, aided by the brain-work of some few hard-handed demigods, produced 7,500,000 better pins.

The changes within the century, which have been the changes, in the main, from semi-barbarism to enlightened civilization, and greater than in the preceding thousand years, comprise advances in every department of industry and the creation of many new arts. A century ago President Washington wore, at his second inauguration, woolen cloth costing $5 per yard, made up at a woolen factory then recently established; while his family, like all others in the land, were clothed principally in homespun. Similar goods would probably now cost $2 a yard, and the people are clothed in the product of the power-loom, then unknown, and only invented two generations later. The spinning-wheel has gone with the wooden clock, the hand-cards, the knitting-needles, of our grandmothers. Exportation of cotton began in 1784; to-day we grow 8,000,000 bales a year, exporting a large fraction, and our woolen-mills turn out 500,000,000 pounds of cloth and other woolen products. A century ago, Great Britain produced but about 75,000 tons of iron, and the United States about 30,000; to-day we see annual products of over a hundred times the larger quantity, and equal amounts in both countries. Steel was then hardly known; to-day we make several millions of tons, and at less cost per ton than was paid for the cast iron of those days. Wages of mechanics ranged from 50 to 75 cents per day, and unskilled labor 25 to 30 cents. But the workmen of that time paid from 16 to 20 cents a pound for meats; $8 a barrel for flour; calico cost 50 to 60 cents a yard, broadcloth of ordinary quality $3, hose $1.25 a pair, and "Nankeen breeches" $5.50. Luxuries, now considered necessaries of life, then cost prohibitive prices, for the average citizen. Sugar, for example, cost 15 to 20, or even 25 cents, a pound. Salt cost 50 cents a bushel, unpurified and unground. Could the people of the last century have visited the World's Columbian Exposition in 1893, they would have discovered the machine-made clock and those greatest wonders of mechanism, the machine-made watches of Waltham and of Elgin; chronometers rated to insensible varia-

tions during a year of use; power-looms making cloths in the most extraordinary variety of patterns, producing even pictures, landscapes, and portraits, in most extraordinary perfection; knitting-machines making garments to fit the form without seam; and cloths of the most wonderful elasticity and softness. They would have been astonished by the cotton-gin and its work, the carding-machines for cotton and for wool, the mineral oils, the gas-light, the electric light, pressed glass and machine-made bricks, machine-made shoes of perfect form and splendid finish, and at a minute fraction of the prices of their time. Iron plows, the mowing-machine, the reaping-machine, the "self-binder,"—cutting the grain, rolling it into bundles, tying it with strong cord, and depositing it in place for the loaders, who, later, carry it to the threshing-machine—steam-driven threshers, and numerous other "farmers' helps" would astound the agriculturist of the eighteenth century. A volume,—a library, even,—would hardly suffice to describe the wonders introduced by the inventors and mechanics of the century now closing, and seen in the Exposition of 1893.

In every department of human labor and production the work of the inventor and mechanic is seen, cheapening costs and increasing the product; giving a single man the powers of a hundred; relieving him from the heaviest burdens; bringing him food and clothing, and every comfort in life, from across the continents and over the oceans; developing for him new industries and diversifying the old; until he is become infinitely safer against the vicissitudes and fluctuations of the industrial tides than ever before. The diversification of industries is perhaps the most obvious and effective of all the results of this progress of a century, and is the grandest of the triumphs of this mechanical age. It is this which gives employment to the steadily-growing population, supplies to skill and talent special fields of work, relieves the lower class of laborers of that competitive pressure which, otherwise, is sure to destroy them by thousands, and gives to the world its opportunities and its progress. The sewing-machine has given employment to a thousand where one sang the "song of the shirt" before, and has introduced a myriad new and beautiful and inexpensive fabrics and garments where the richest, formerly, could only obtain a limited number after long, patient, and killing toil on the part of the makers; and even the accelerating rotations of the fashions, promoted by invention and varied industries, aid in giving to the poor of the substance of the rich, and in equalizing, for all, the distri-

bution of the best of the world's most useful and continually increasing variety of good things.

In a generation, the wealth of the civilized world has doubled, and mainly to the advantage of the poor and the less wealthy classes. Wages have doubled, and the purchasing power of the dollar has, in most directions and on the average, increased 50 per cent. and more. Mr. Giffen asserts that the rich have become more numerous, the poor less numerous; and the intermediate classes are all much better cared for and richer than formerly. "The poor have had almost all the benefits of the great material advance of the last fifty years." This, as that writer remarks, is not so much an improvement as "a revolution of the most remarkable description." Where, as in cotton-spinning, a man can now do, with the aid of machinery, four or five times the work that he could have done a half-century ago, and can obtain twice the wage for his shorter day's labor, it is obvious that the world must, on the whole, have gained enormously in wealth, comfort, and happiness. And this has come largely of this direct stimulation of production due to the introduction of modern inventions and machinery, and largely, also, of that diversification of industries which the resulting increase of wealth and available time has rendered possible. The innumerable wants of the wealthy, the numberless comforts of the well-to-do, and the continually growing list of what are now considered necessaries of life for the poor, promise to make the further diversification of the industries and the widening of the new fields in which time and thought and labor have their applications, a permanent feature of human life henceforward. And this prospective increase and continual improvement will unquestionably inure, in the future as in the past, mainly to the advantage of the workers themselves. Already, as shown by Mr. Edward Atkinson, 90 per cent. of the people are at once producers and consumers, and these classes are "decade by decade, securing to their own use and enjoyment an increasing share in a steadily increasing product."* As has been so well shown by Mr. David A. Wells, "the time has come when the population of the world commands the means of a comfortable subsistence in a greater degree and with less effort than ever before; and what we may reasonably expect to see at no very remote period is the dawn of the day when human poverty will mean, more distinctly than ever before, physi-

* *Century Magazine*, 1887.

cal disability, mental incapacity, or unpardonable viciousness or laziness."

This is the lesson of the century taught at the World's Columbian Exposition. We saw there acres of steam-boilers and engines, aggregating between 20,000 and 30,000 horse power, distributing their enormous energies to 100,000 electric lights of 12,000,000 of total candle-power, driving great pumps supplying many millions of gallons of water to its myriad purposes, impelling, through the flexible arm of the electric genius, boats on the water and railway-trains on the land; illustrating in every known way the world's progress in transportation. This great power moves innumerable ingenious and powerful machine-tools, capable of shaving iron and steel into ribbons, cutting masses into blocks, giving the most absolute perfection of form and proportion to every piece. It is these machines which make for man all the rest. The sewing-machine in unending variety; the type-setting machine; the printing-press, and countless others, exemplify the wonderful ingenuity of the modern inventor and mechanic; and locomotives of more than a hundred tons weight, capable of drawing two thousand tons at a load across the continent, or of driving over the routes between great cities at speeds of fifty and sixty, and for short distances, eighty and a hundred miles an hour, show the latest and greatest of the developments of railway machinery. Models of the *Campania* and of the *Paris* show what inconceivable concentration of power into these great iron hulls illustrates the ingenuity and talent of the marine engineer and naval architect, and permits the effort of a hundred thousand horses and more, the actual equivalent, in living muscle, of 30,000 horse power of the ships of latest construction, to be applied to the driving of 10,000 tons across the Atlantic in a little more than five days,—the most wonderful of all the marvelous modern achievements of the mechanical engineer. The multiple-telegraph systems, the long-distance telephone, and the Gray teleautograph exhibit the mysterious power given by the electrician; communicating signs, words, fac-simile letters, the sound of the voice, and perhaps even sight, ere long, across the world. The great Reynolds-Corliss and the dozens of smaller engines in Machinery Hall, and the Jacquard loom, side by side, give evidence that the days of the Greek demigods have only now really begun to find real place in history. The real demigod is he who has performed these miracles in the reduction of the great energies of

nature, in sun and earth and coal-bed, of heat and light and electricity, to the service of his fellows and the race.*

Viewing this gigantic epitome of an almost infinite industrial world, one cannot but be gratified to see how nobly the inventors and the mechanics of the United States have held their own, and how well in the van they have marched in this great movement toward a better and a higher civilization. American inventors have supplied the world with many of its most valuable,—especially among the later,—improvements in the arts; American mechanics have shown the world how production can be made most perfect and most fruitful. Studying the grand result, in this immense cyclopedia, we may well exclaim, with Charles Sumner: "This is our talisman: Give us peace, and population will increase beyond all experience; resources of all kinds will embellish the land with immortal beauty; the name of the Republic will be exalted, until every neighbor, yielding to irresistible attraction, seeks new life in becoming part of the great whole; and the national example will be more puissant than army or navy for the conquest of the world."

The study of this all-comprehending cyclopedia of all the arts has thus been of peculiar value to the contemporary mechanic and inventor. Every one who visited the Exposition could see all that the world has accomplished to date, and just how this has been done; every product of every art and manufacture, and every form of mechanism by which their production has been effected, was there placed before his eyes, and he was thus given an opportunity for comparison, not only of one with another, but of all with his own conceptions of old and new inventions, and of his own devices, in such manner that the very best methods and the most effective mechanisms have become known to him, and he has obtained a clear idea of just what is being done by the best mechanics of the world and how they are doing it. He has acquired a knowledge

* The following is a Census summary of the investments in electric light and power distributions, made up in 1891 or 1892, covering the United States only:

INVESTMENTS IN THE ELECTRICAL INDUSTRIES.

Telegraph companies	$125,000,000
Telephone companies	100,000,000
Isolated plants	6,000,000
Central-station plants	155,202,850
Electric railways	70,000,000
Fire-alarm and police-patrol plants	10,000,000
Steamboat plants	1,000,000
Sundries industries	10,000,000
Manufactures	75,000,000
Total investment	$552,202,850

of "the state of the art," as a patent lawyer would say, and is ready to go on, from its most advanced position, into new and richer fields. It is thus that the arts and inventions of the time have most surely and effectually received an impulse such as could by no other possible means have been given them. The International Centennial Exhibition at Philadelphia in 1876 illustrated this fact, and we may confidently anticipate a still more observable and still more tremendous impetus in every branch of mechanics as a result of the enormously greater Exposition of 1893. Every good mechanic and every great inventor in the land has seen the mechanism and the invention of the contemporary world at Chicago, and now sees his way, more clearly than ever, to new and greater conquests, with corresponding advantage to himself and his fellows.

The direction of the progress at the moment observable in the various arts and sciences, and the character of the inventions coming into view, and their immediate further advance, and even their limitations, so far as our present knowledge goes, may sometimes be discovered or reasonably anticipated. As the writer has sometimes taken occasion to remark, "Nature never turns a sharp corner"; inertia is as effective, in many directions, in intellectual as in physical phenomena. A line of progress marked out for a generation, or followed for a century, may usually be safely presumed to be that to be pursued in the immediate future. For example, in the case of the steam-engine, the improvements of the century have been constantly in the direction of increasing steam pressures, higher piston-speeds, greater expansion, better regulation, and, in general, continual gains in lightness, volume, concentration of power, economy, and perfection of adaptation to the special requirements of every branch of manufactures. Every invention of Watt, and every improvement since Watt having any importance and success commercially, has contributed to advancement in these lines. The immediate future, we may be sure, is likely to see further gains in power and economy, through still further rise of pressures, of expansion-ratios, of speeds of machinery; while the tentative constructions, the multiple-cylinder engine, the balanced mechanisms, the shaft-governors, the sectional boilers, are becoming accepted and standard. Perkins and Albans, a half-century ago and more, employed safely pressures of 1000 and 1500 pounds on the square-inch; we are now slowly and toilfully approaching, in regular and standard work, the "low" pressures, as they con-

sidered them, which they regarded as safe for common use. The conservatism of James Watt and his contemporaries and successors has been the retarding element in this progress; the introduction of safe forms of steam-boiler has been the countervailing element of progress. Watt thought seven pounds high enough when Trevethick and Oliver Evans would have employed a hundred; modern engineers only await the onward lead of the constructor of the boiler, and the yielding of popular prejudice, to carry the advance rapidly to its natural limit. Just where this limit will be found, no one can yet say. We may perhaps surmise that it may not be far from 250 pounds on the square inch for ordinary work. Thermodynamically, there is no limit within the range attainable with temperatures below those of softening of our materials of construction, and, as in the gas-engine, we may be able to greatly exceed, by controlling devices, even that limit. Extra-thermodynamic wastes introduce a check which seems likely,—if we can find no way of overthrowing the present type of engine and of substituting for the heat-engines electric-dynamic apparatus, like those of Nature's vital machines, perhaps,—to enormously restrict the final, the commercial, efficiency of the steam-engine, and our surmise that the limit for the immediate future may be found at not far from about fifteen atmospheres of pressure is based upon this fact.

Similarly, in transportation on the ocean, we see steady growth in size and speed of ships; but we see, at the same time, that a limit is here being constantly approached, and with continually greater difficulty, at which the ship cannot carry the machinery needed for its propulsion at the higher speed constituting that limit; unless, indeed, some new system of power-production, or of application, or of both, shall set that limit still further away. Shipbuilders are now discussing the practical possibility of attaining thirty knots an hour and of crossing the Atlantic in four days. Given the capital, that limit can certainly be exceeded to-day; but a limit remains somewhere immediately beyond, nevertheless. The famous locomotive "999" has made its hundred miles and more; but it is known to its constructors that the proportion of power expended on the engine itself continually increases with rising speeds, and that there will come a time, possibly at 150 or at 200 miles an hour, at which the machine could only carry itself, and the limit of railway transportation of passengers, with known means of application of steam-power, must certainly be found somewhere well within that point, even assuming it to be possible to

commercially succeed with such enormous speeds and such consequently costly transportation. It looks very probable that a hundred miles an hour may remain a practical limit of fastest trains for some time to come. Whether the steam-locomotive will be then or ever superseded by some other, as the electric motor, probably no one can say ; although many well-informed engineers are very sanguine that this will follow, and soon. And in every department of applied science and of art, we are finding limitations, for the time at least, of our forward movement ; but we are, in every case, gradually finding ways of steady, if slow, removal of the contemporary limit.

These illustrations of progress in all the departments of industry teach, not only that continued and indefinite advance is being made in the power, economy, productiveness, and efficiency of all sorts of machinery and apparatus of industry, but also that every step is one of advantage to the race. Every new process and each new invention gives the worker the power of doing more for himself and his fellows. History proves clearly that the whole race profits by every such advance. Wages rise, and purchasing power increases steadily with the equally steady improvement in all the arts. Here and there a man or a class of men may be thrown out of their accustomed places by some new improvement ; but, in the United States at least, they speedily turn their hands to the new opportunities surely opening to them, and it is soon found that more work is made for all, and better and more fruitful industries are developed, by the change. It was feared, when railroads were introduced, that the whole British stage-coach business would be destroyed, with great loss to the people as a whole, and that the horse would cease to have work or value, if the new system were to be adopted ; but, as has been often remarked, more horses and more stage-coaches and omnibuses are employed to-day in taking away passengers from the trains in the cities of Great Britain, than were then in use in the whole country, for all purposes of transportation or of manufacture.

These are the lines of development—the work of the mechanic and of the inventor—on which the future of our country is to depend ; and it is in these directions that we are to work to make the United States the foremost among nations.

INTERNATIONAL EFFECTS OF THE FAIR.

By Edmund Mitchell, M. A.

SINCE the year 1851, when the Crystal Palace Exhibition in the metropolis of Great Britain inaugurated the system of international expositions, many world's fairs have been held, in widely-separated lands. The series runs: London, 1851; Dublin, 1853; New York, 1853; Paris, 1855; Munich, 1854; London, 1862; Dublin, 1865; Paris, 1867; Vienna, 1873; Philadelphia, 1876; Paris, 1878; Sydney, 1879; Melbourne, 1880; Paris, 1889; and Chicago, 1893. It has fallen to the lot of no single individual, perhaps, to witness all these great industrial gatherings of the nations. The several expositions were of varying degrees of pretentiousness, but it has been universally conceded that the one in Paris in 1889 eclipsed all previous ventures of the kind, both as regards grandeur of conception and brilliancy of execution. Accordingly, one does not need to be a Nestor among exhibition-goers to get at a reliable line of comparison between the great World's Columbian Exposition at Chicago and the international fairs that have preceded it.

A considerable number of the European visitors who made the pilgrimage to the shore of Lake Michigan had seen the first Exhibition in London, and had also participated in the Parisian, Viennese, and Philadelphian celebrations. Among these men, whatever their national predilections and their views on points of detail, there was a unanimous and freely-voiced consensus of opinion that the City of White Palaces in Chicago has never had a compeer as regards architectural magnificence. There might be conjured up to the mind's eye individual buildings in other parts of the world that were perhaps more strikingly beautiful than any of the structures in Jackson Park, but it was universally allowed that never before had there been such a massing of glorious palaces, such exquisite grouping of noble buildings amidst an unrivalled setting of lake and lagoon, splashing fountains and balustrated bridges, statuary and stately colonnades, islands and avenues, landscape designs and floral effects.

Never in history had such an architectural panorama been conceived by the brain and fashioned by the hand of man. The sur-

passing loveliness of the night scene, when the Court of Honor and the Wooded Island were lit up by myriads of electric lamps, dotting out every curve and angle in the beautiful façades of the buildings, tracing with lines of fire the Grecian Peristyle with its noble columns and magnificent surmounting statuary, outlining in the heavens the graceful dome of the Administration building, dancing amidst the rainbow-hued spray from the electric fountains, running around the balustrades that encircled the gleaming waters of the lagoon, shedding over lake and verdant turf and dazzling white pillars alike a soft effulgence that paled the moonlight, while gigantic search-lights stole ghost-like across the field of view, sending cones of luminosity over the broad bosom of Lake Michigan, causing distant domes and minarets of the Midway Plaisance temples and palaces to glisten like carven mountains of ice, penetrating beyond the roaring city to the silent prairie where the buffalo used to roam and the coyotes held village council—this assuredly was a grand and glorious spectacle that never before even in faint outline had been presented to the eye of man. It was, by universal admission, the veritable realization of an artistic dream that heretofore had existed perhaps only on the pages of some Arabian romancer.

Writing in London, fresh from an eight-months' sojourn in Chicago, and with the picture of exquisite loveliness indelibly impressed on my mind, I am simply amazed at the amount of misconception among stay-at-home Englishmen of what the Columbian Exposition really was. Comparatively very few Britishers crossed the ocean to behold for themselves the grandeur and magnificence of the White City. The British press has done little or nothing to supply an accurate idea. The flight of newspaper correspondents from across the Atlantic, that descended upon Chicago for the inauguration on May 1 and then took wing after a rest of only a week or ten days at the Fair, carried back reports of incompleteness in construction and installation the reproach of which was wholly removed in a very few weeks' time. When the culmination of success was reached, there were few special correspondents on the ground, and the subject of the World's Fair had been virtually dropped in both the metropolitan and the provincial press of England. Other causes had contributed to this journalistic "happy dispatch" accorded to the great Chicago enterprise. Soreness over the McKinley prohibitive tariff had undoubtedly caused many of the leading manufacturers in England to hold themselves entirely aloof

from the exhibition, and in the great industrial centers the interest of participation was accordingly absent. Moreover, the newspapers of New York are, of all American journals, the ones most commonly read in Great Britain, and the not too kindly comments of its daily press in the early weeks of the Fair helped to root the idea in the minds of the English public that the undertaking had proved a comparative failure. But the men who actually saw, and who are therefore the only competent judges, have been cordial and unstinting in their praise.

In my own case the practical aspects of the World's Fair impressed me most. For example, to visit the vast Transportation building and its annexes, and to learn that this was an entirely new department in the history of international exhibitions, was a perfect revelation. The marvelous variety, the historical completeness, and the splendid classification of the exhibits in this section, making transportation one of the grandest fields for study in the whole Exposition, appeared to be the result of twenty years of gradual improvement in preparing such a display, rather than what it was virtually,—an experiment. The achievement of such results under the circumstances forcibly showed the foresight, enterprise, and organizing ability of the men at the head of affairs in Chicago. Again, it was truly marvelous to witness in the Electricity building the dynamos and other appliances which were shown at the Philadelphia Exhibition of 1876, displayed side by side with the most modern electrical machinery, their relation to the latter being simply that of *archæological curiosities*. It was a strange sensation to lay one's hands upon the first telephone, the first phonograph, the first arc lamp, the first electric motor,—to look upon them and examine their parts with much the same feelings as one stands within the pyramids of the Nile and inhales the musty atmosphere impregnated with the dust of mummies five thousand years old, and yet to realize that they are, each and all of them, but inventions of yesterday. No such object-lesson, showing the giant strides of the youngest of all the sciences within the past twenty years, and indicating its vast potentiality in the near future, was ever afforded. Similarly, in mining, machinery, manufactures, viticulture, pomology, agriculture, and dairying, practical lessons of a hardly less impressive character were everywhere to be learned by the observant visitor.

It has frequently been contended that international exhibitions have done little permanent good to mankind,—that they are really

carnivals of pleasure, that industry does not profit by the lessons they profess to teach. The complete falsity of such an argument must have been borne home to the mind of every one who made anything like a conscientious study of the Chicago World's Fair. Let me give one or two specific instances of ideas being exchanged at these exhibitions; and in doing so I shall of set purpose select small things, to show that even the most minute details do not escape the lynx-eyed visitors. At Philadelphia, in 1876, Switzerland was completely cut out by America in the department of watch-manufacture, the machine-made article of the latter country eclipsing the hand-made product of the former. At Chicago, in 1893, we witnessed the Swiss artisans making watches by the aid of all the latest and most delicate American machinery, and in not a few instances beating the United States manufacturers with their own tools. Had not an invaluable lesson been learned by the Swiss in this case? Similarly, in the section of dairying, a number of beautiful new appliances, such as the Babcock milk-tester and the Scovell sampling-tube, were shown in operation, and most careful and elaborate descriptions of the experiments and processes, together with specimens of the machines, were promptly dispatched to Denmark, Sweden, Australia, the Cape of Good Hope, and other countries where the production of butter and cheese is one of the chief industries pursued. The outcome cannot fail to be an appreciable improvement in the dairying resources of the world. Again, on the Chicago lagoons the picturesque but antiquated Venetian gondola was seen side by side with the far more speedy and effective electric launch, with the result that we read of the latter vessel having been introduced on the canals of the Italian city. Similar examples of adoption following close on the heels of exhibition could be indefinitely multiplied, but the three cases I have quoted show with sufficient clearness that a well arranged international exposition becomes virtually a clearing-house of ideas for the whole civilized world.

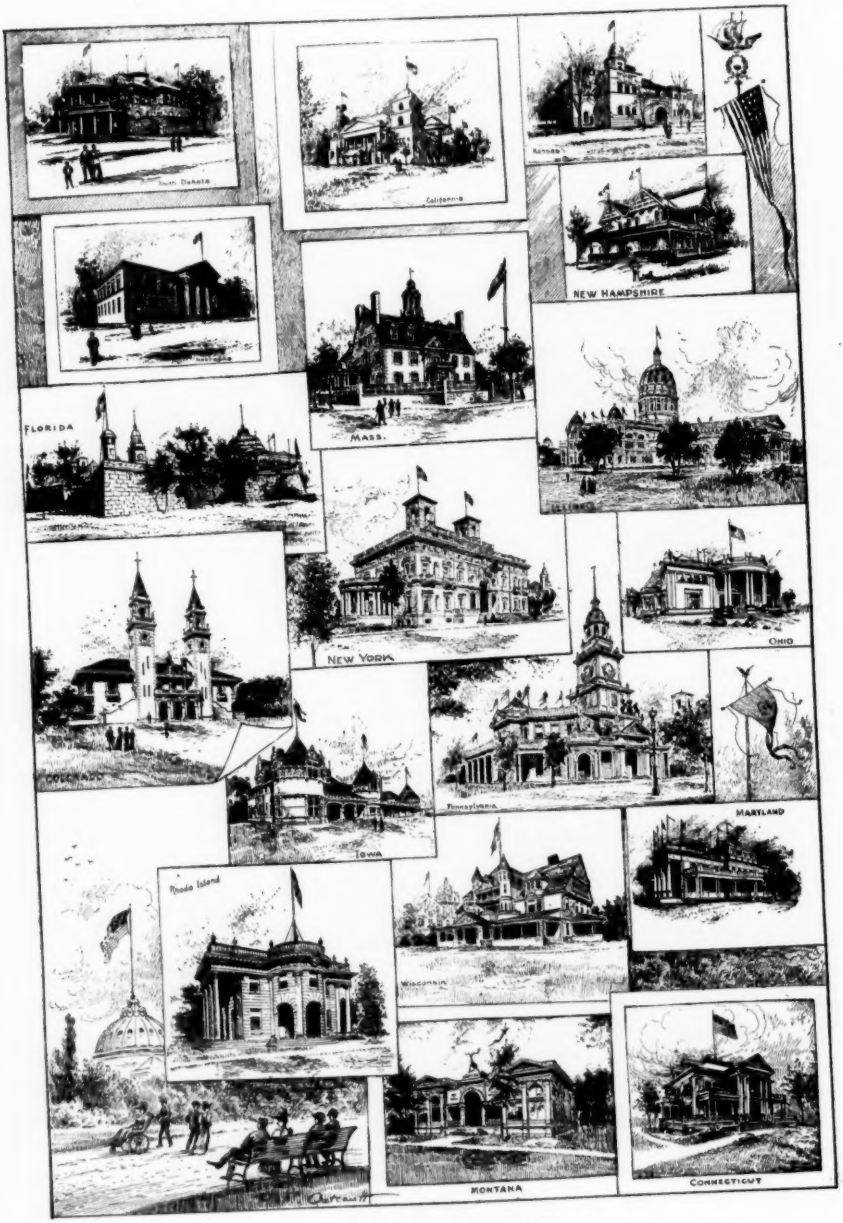
To my mind, also, not the least valuable result of the Chicago World's Fair was the spirit of fraternity diffused among men of many varied races. Sentiments of brotherhood seemed to be in the air. In this respect Chicago gained an undoubted advantage over Paris, Vienna, and every other European center of population. On the soil of America there is no field for international bickerings and jealousies. At Chicago German and Frenchman, Englishman and Russian, Turk and Bulgarian, met together on every festive

and ceremonial occasion, and came to know each other, to appreciate each other, and to regard each other as warm personal friends. More especially was this happy result brought about by the excursions from Chicago into the surrounding country proffered by the American people among many other hospitalities to their visitors from abroad. Notable among these was the trip to the wheat-fields of North Dakota organized by the Chicago, Milwaukee and St. Paul and the Great Northern railway companies, on which occasion men of twenty nine different nationalities, speaking fifteen different languages, fraternized together during a period of nine days and became intimately acquainted—an incident which, I venture to think, is almost without parallel. The spirit of brotherhood engendered by this close association was shown at Gretna, a village on Canadian soil, where the stars and stripes of the United States and the union jack of Great Britain and Ireland were saluted, and the happily expressed sentiment, "May the Old Glory of the New World always float side by side in amity with the Older Glory of the Old World," was cheered to the echo by Americans and Englishmen, Frenchmen and Russians, Germans and Poles, Italians and Spaniards, Swedes and Norwegians, Austrians and Turks, representatives of every South American republic and colony, and men from far away Australia, the Orange Free State, and Japan. It augurs well for the federation of mankind that such a chord of friendliness should have been struck and echoed through so many countries of the world. A little leaven leaveneth the whole lump, and the scene at Gretna on August 28, 1893, is one that will live long as a kindly memory in every corner of the globe.

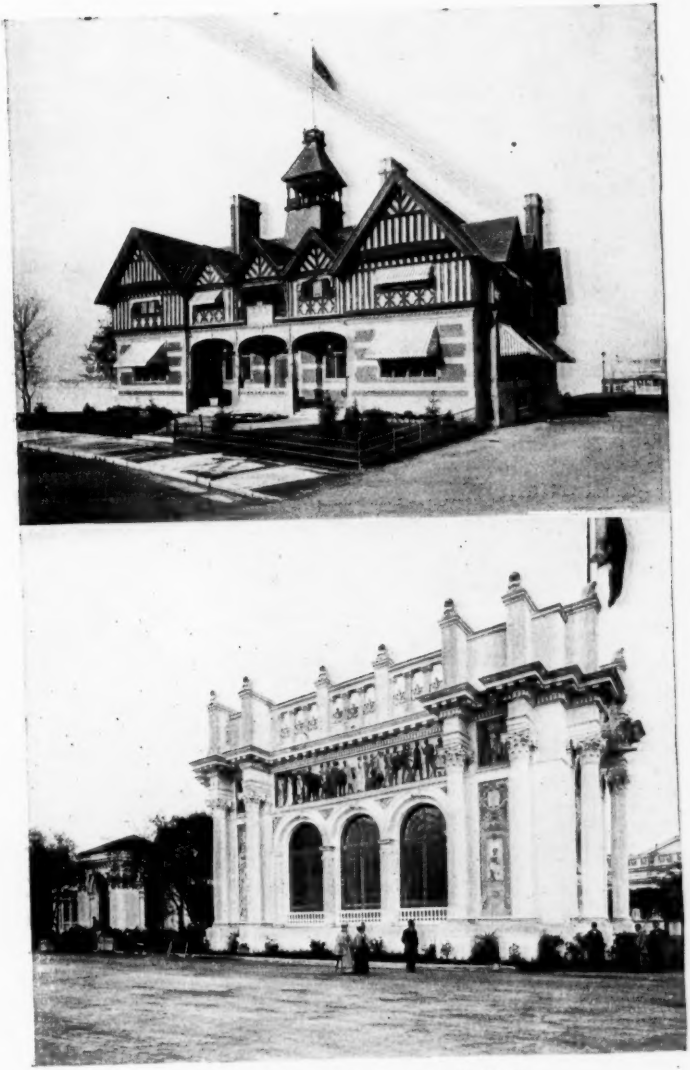
I would say, in summing up a few of the special features of the World's Fair, that Chicago itself must not be forgotten. To the thoughtful observer from abroad, perhaps of more supreme interest than all the exhibits within Jackson Park was this young giant city of the West, with its striking architectural features that mark a distinct epoch in building engineering, with its teeming and polyglot population, with its phenomenally rapid commercial growth, with its web of concentrating railways, with all its feverish energy and enterprise. No foreigners can have lived in Chicago during the summer of 1893 without being profoundly impressed by the greatness of the American people as evidenced in these sons of the West, their throbbing mental activity, their courage, their resourcefulness, and their indomitable perseverance. This lesson is not the least important result of the Columbian Exposition.

VIRGINIA STATE BUILDING (MT. VERNON).

THE FERRIS WHEEL.

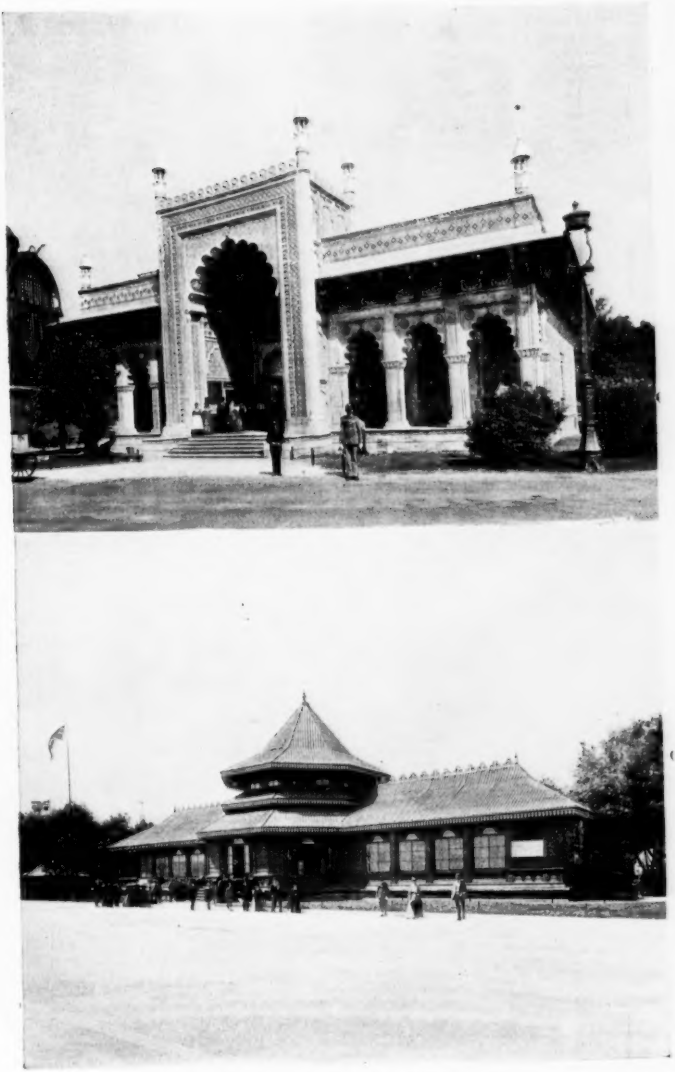


A GROUP OF STATE BUILDINGS.

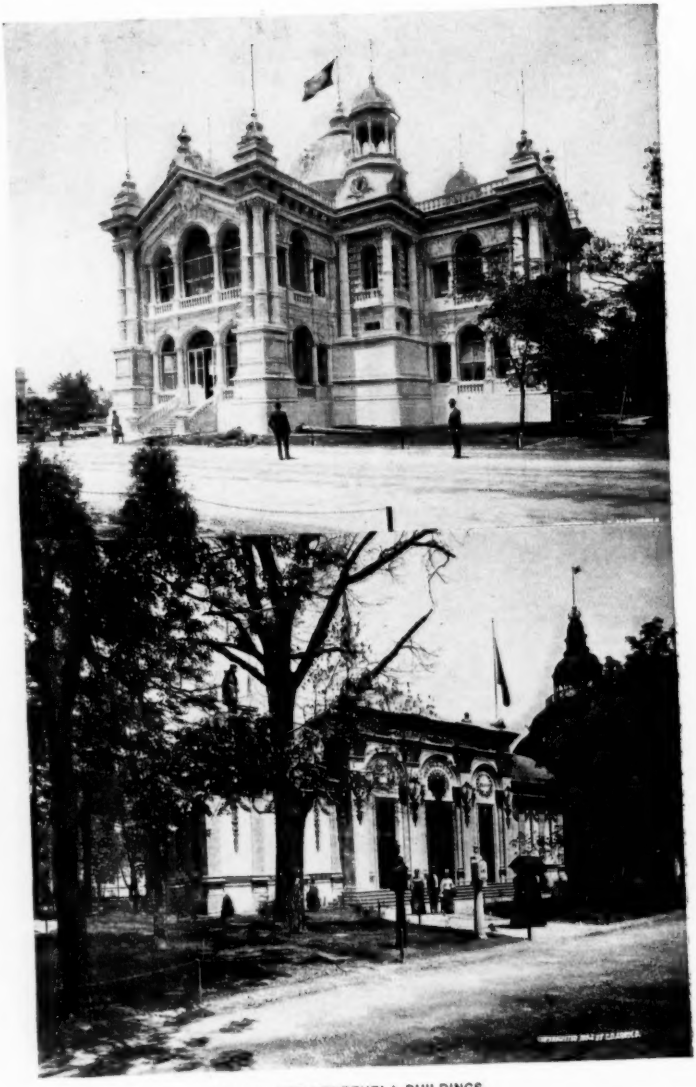


BUILDINGS OF GREAT BRITAIN AND FRANCE.

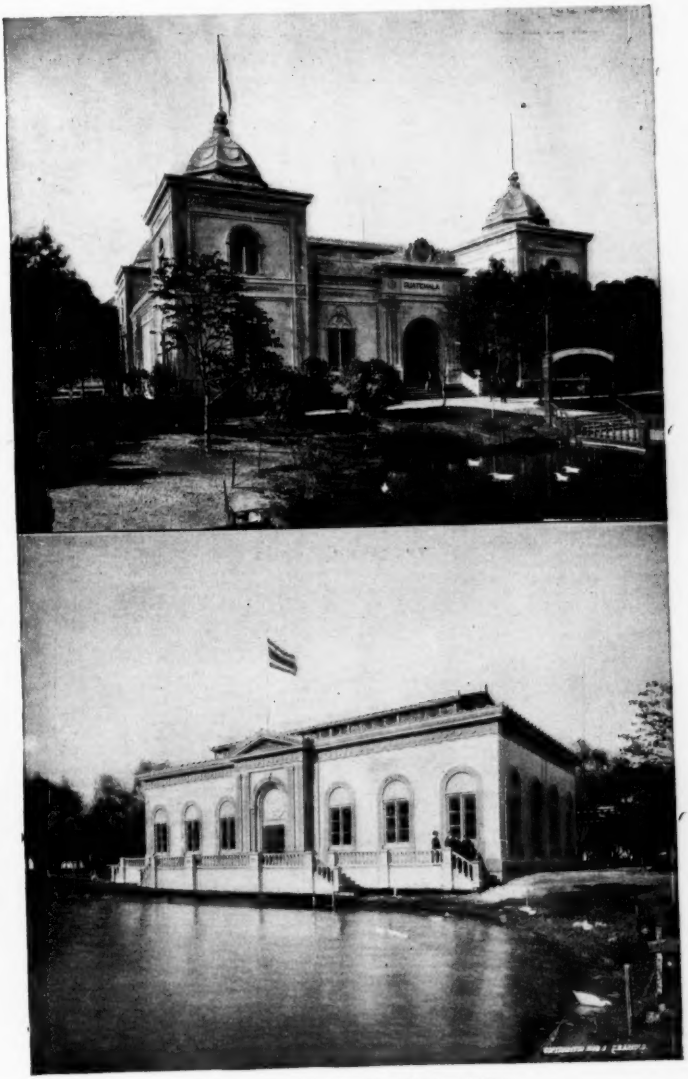
BUILDINGS OF NORWAY AND SPAIN.



INDIA AND CEYLON BUILDINGS.

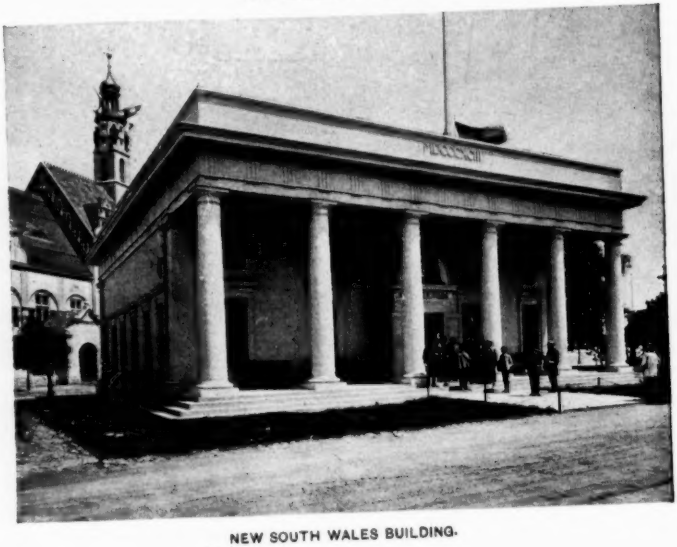


BRAZIL AND VENEZUELA BUILDINGS.



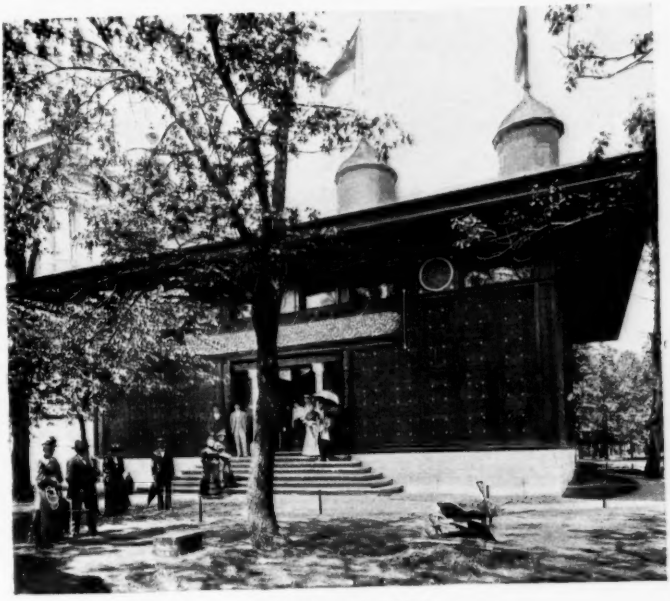
GUATEMALA AND COSTA RICA BUILDINGS.

THE CANADA BUILDING.



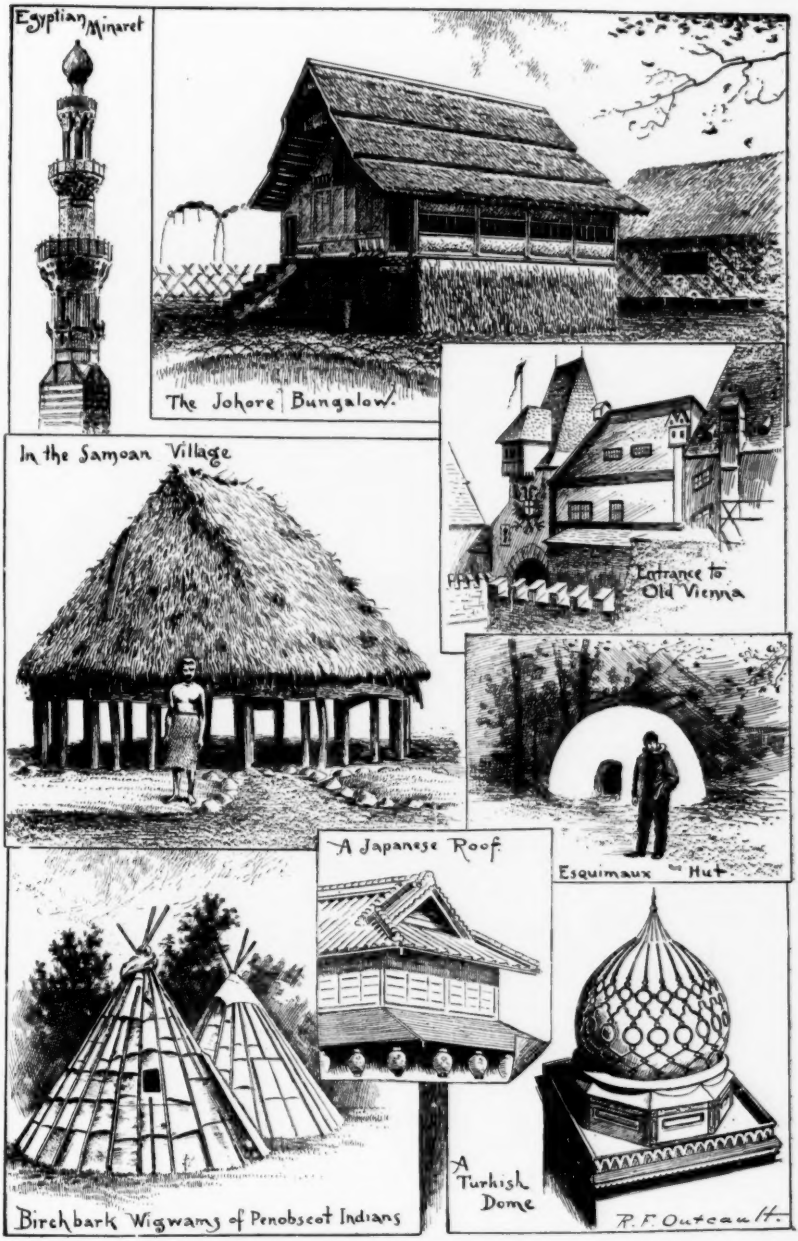
NEW SOUTH WALES BUILDING.

THE FORESTRY BUILDING.

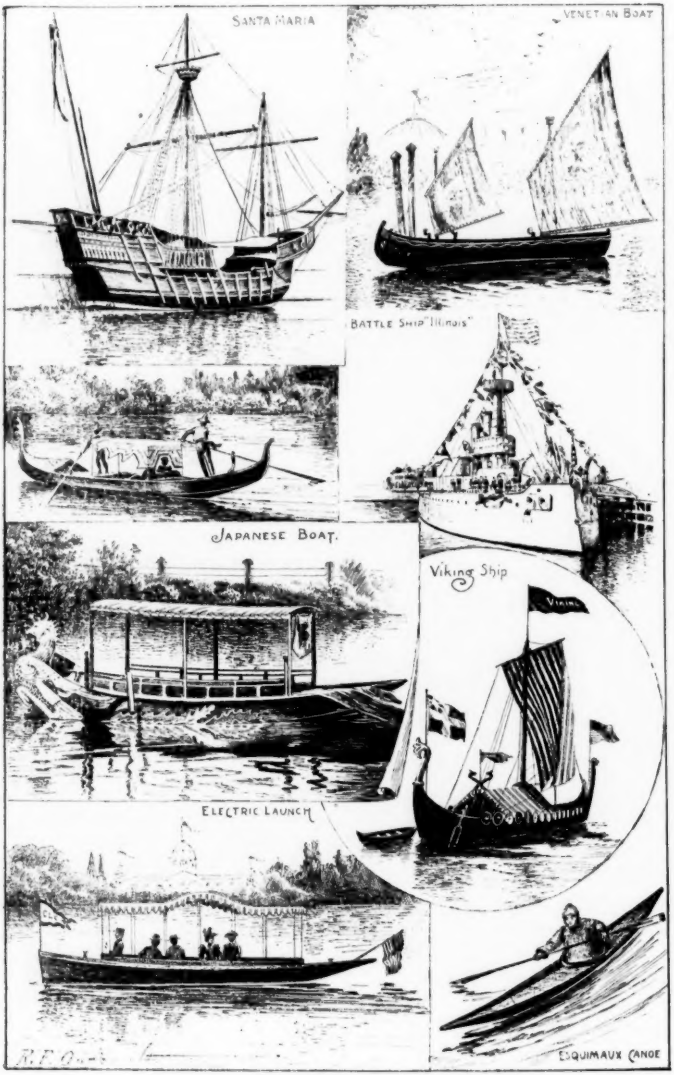


THE TURKISH BUILDING.

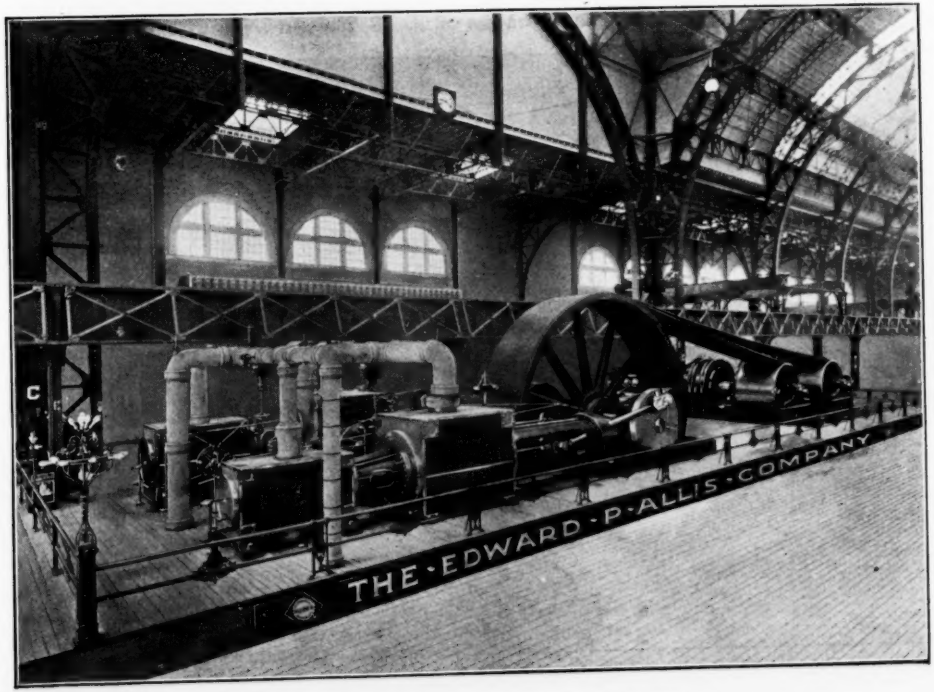
THE SWEDISH BUILDING.



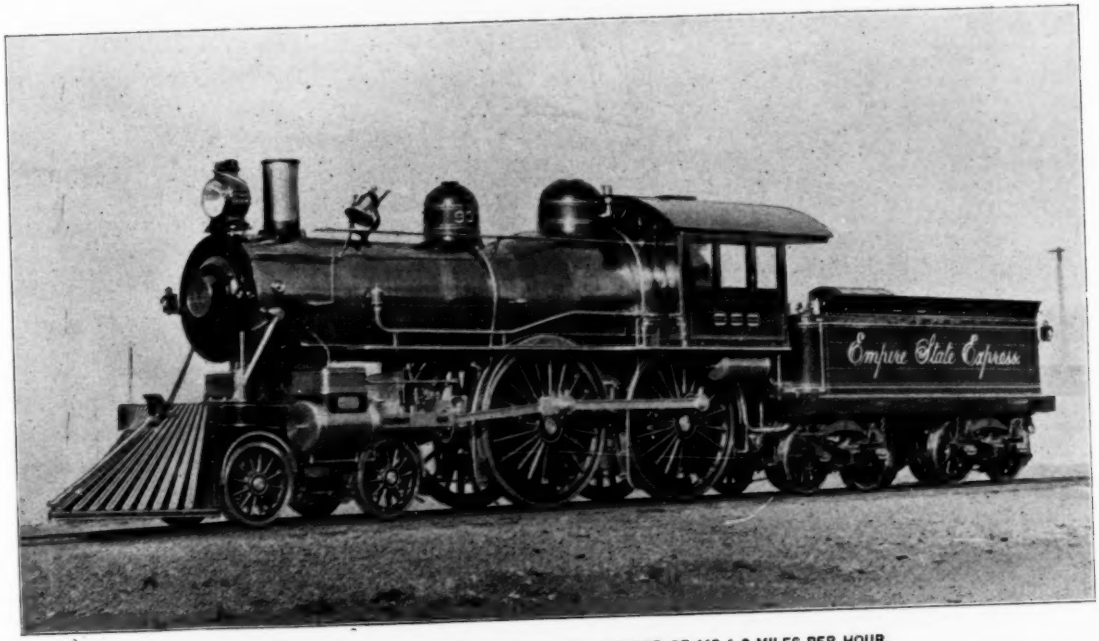
FRAGMENTS OF ARCHITECTURAL ODDITIES.



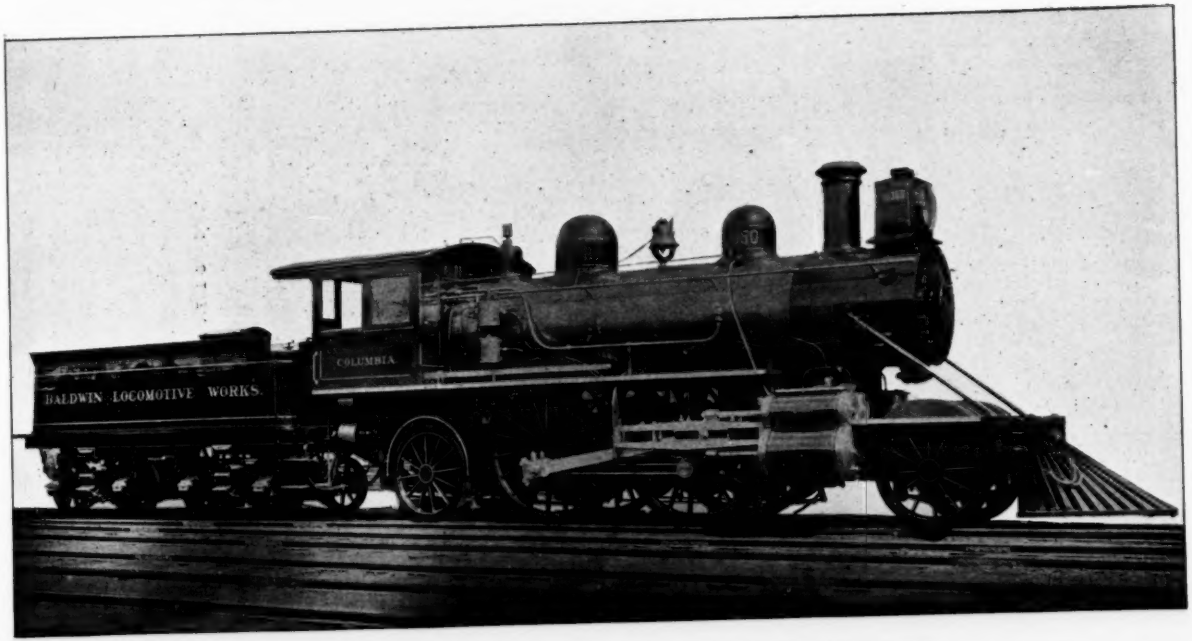
A COLLECTION OF VIEWS AT THE FAIR.



THE GREAT ALLIS ENGINE—MAXIMUM RATED CAPACITY, 4000 H.-P.



NEW YORK CENTRAL PASSENGER ENGINE NO. 999—RECORD OF 112 1-2 MILES PER HOUR.



SPECIAL "HIGH-SPEED" PASSENGER LOCOMOTIVE, 1893—BALDWIN LOCOMOTIVE WORKS.

GERMAN GOVERNMENT BUILDING.

THE MINING INDUSTRY AT THE WORLD'S FAIR.

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NOW that the World's Columbian Exposition has passed into history, description of its wonderful beauty and spectacular attractions are perhaps out of place. To those who saw it, they would be superfluous ; to those who have lost that unique opportunity, they would be irritating. At all events, such descriptions have been abundant enough, during the past six months ; and I do not purpose to add to that abundance now.

The department of Mines and Mining, like the Exposition as a whole, presented many ingenious and striking features, calculated to impress the casual beholder and to emphasize the more permanent truths which they conveyed in object-lessons. In this retrospect it is more important to consider the substantial truth than its pictorial expression ; and therefore I shall here consider, in the main, two questions : How complete was the representation of the mining industry at the Exposition ? What general reflections does this exhibit suggest ?

It seems necessary to remark at the outset, that the mining industry is, for the purpose of a classified exhibition, very vaguely defined. No doubt mining, like fishing and fish-breeding, hunting and cattle-raising, agriculture and forestry, is one of the primary productive industries, and deserves a department to itself. But such a department inevitably comes to contain exhibits of metallurgical and chemical manufactures and of various machinery, which are represented also (and perhaps more completely) in other departments. This is especially likely to occur when, as in this case, the available room is crowded with the independent displays of nations, States, and individuals, whose means, material, and methods cannot be rigorously prescribed.

Thus it came to pass that the mineral resources of many nations and States were illustrated in their own buildings, rather than in the Mines and Mining building ; that the principal geological sections and models of the United States survey were in the United States government building ; that many machines employed in mining were to be found in Machinery Hall or in the Electrical and Transportation buildings ; and that the work of technical schools in mining and metallurgy was illustrated chiefly in the galleries of the

Manufactures and Liberal Arts. On the other hand, the Mines and Mining building contained the magnificent exhibit of the steel-works of the brothers Stümm in Germany, and scarcely anything from American steel-works. The big Bethlehem hammer, and the displays of that and other companies, were in other places; while Krupp had a palace to himself.

This was to have been expected; and I mention it, not as a blameworthy defect, but rather in order to express the pleasurable surprise experienced by all mining engineers and metallurgists who visited the Exposition, at finding the exhibits in the department of Mines and Mining so large, well-arranged, comprehensive, and instructive. To say that this department, as a whole, surpassed in these respects anything hitherto offered in the same line on a similar occasion is to say but little; for the mining departments of previous expositions had set no very high standard of excellence. Moreover, no very high expectations were entertained concerning this one; and it is no secret to those who know anything of the interior history of the management at Chicago that the highly creditable success achieved in this case was due to the indomitable energy and administrative genius of J. F. V. Skiff, its chief, who secured for his department both the respect of his colleagues and the support of the public which it represented.

Even a general survey of the contents of the Mines and Mining building can scarcely be compressed within the limits of this article. For the purpose of a summary statement of first impressions, such as one might give in an off-hand talk with a friend, I would class the whole under the following heads:

I. Mining resources.

II. Products and processes, machines and apparatus, both mining and metallurgical.

III. Exhibits of methods and means of instruction, including statistics in graphic or dimensional forms.

IV. Spectacular exhibits.

The prevailing principle of arrangement being necessarily geographical, nearly all of the classes were scattered throughout the building, so that the completeness of any one of them (except the first) could not be easily estimated. My impressions, based upon a number of visits, but not upon a thorough detailed study, are therefore stated with some hesitation and self-distrust.

The representation under the head of mineral resources was thoroughly good as regards most of the States and Territories of

the Union, astonishing as to some foreign countries,—notably New South Wales,—fairly comprehensive as to others, such as Canada and Mexico, and far from complete, though still interesting and extensive, with regard to Great Britain and European nations. With the exception of the magnificent exhibit of New South Wales, which can only be interpreted as the expression of colonial pride and public spirit, the relative excellence of the various geographical divisions in this case was, in the main, what might have been expected upon due consideration of the two factors of distance and commercial relations. Naturally enough, those regions the mining industry of which seeks American custom or American capital, presented the most abundant display of their mineral resources. While this legitimate motive may not be depreciated, all the more credit is due to New South Wales for the superb and comparatively unselfish contribution sent as a greeting to the New World from the newest. Apart from this international compliment, which Americans are not likely to forget, the exhibit was an overwhelming revelation of the natural wealth, industrial energy, and inevitable future greatness of the Anglo-Saxon antipodes. History bears witness that the mere mining of the precious metals, while it has often been the starting point of new conquests of civilization, has never built up prosperous and permanent commonwealths, in the absence of the necessary bases for other industries. It is the surest indication of the assured future of New South Wales that her product of coal already exceeds in value her product of gold. If she did not possess that element of power, all her gold would not buy it for her.

Similar reflections are suggested by the exhibits of some of our own States, heretofore associated in the public mind chiefly with gold- and silver-mining. It is difficult to produce a fresh sensation by the mere display of nuggets and rich "quartz" specimens; and in the splendid exhibit of Colorado, even the collection of gold nuggets from Breckenridge and San Miguel, the most valuable, perhaps, ever brought together, was less impressive than the wonderful balustrades and columns of Colorado marble, sandstone, granite, onyx and alabaster, and the specimens of coal, asphalt, petroleum, and iron-ore, which testified to the rich variety of the natural wealth of that favored State. The same might be said of other parts of our great West, including California, and excepting only Nevada—which, unless I am mistaken, was not separately represented at all in the building.

The principal general impression derived from this geographical exhibit of mineral resources is that no nation can claim a monopoly of any really important mineral product. It is ridiculous to talk of silver as "American," and gold as "British." The commercial corollary of this theorem is, that no nation, by itself, can "corner the market" or fix the value of any important mineral product. The exhibit of amber from Germany is the only exception that I remember seeing. As to the cryolite of Greenland (which I did not see), it is a temporary monopoly, and deposits of the mineral are known in the United States; and as to tin, it is not produced by one nation only, although this country produces at present only specimens of the ore for exhibition!

Among our own States, there is an equal absence of monopoly, the only exception to which, so far as I recollect, was furnished at Chicago by the fresh-water pearls of Wisconsin. And if pearls should prove essential to prosperity, I have no doubt they will be discovered or manufactured by other enterprising States.

Perhaps I may be told that I should have included, as a substantial exception, the anthracite of Pennsylvania; and I must admit that, considered apart from other coals, anthracite does constitute for that State a practical monopoly, although it is commercially so restricted by competition that it has never returned large profits upon the capital invested in mining and transporting it. I might, however, defend my omission to mention it above, by calling attention to the mining of local deposits of anthracite in New Mexico and Colorado, which, although it can enter into no commercial competition with the product of Pennsylvania, may furnish to the cities of the Rocky Mountain region a domestic fuel of no small value from the standpoint of cleanliness and comfort.

Finally, the immense abundance and wide distribution of the economically important minerals of the United States, as illustrated at Chicago, was more profoundly impressive as an augury of the future than as an evidence of the present. Especially in the matter of coal and iron-ore, it is evident that we possess much more than can be immediately exploited to advantage. No doubt the most favorable points will continue to be energetically attacked and more or less wastefully exploited. The newly discovered iron-ore deposits of the Mesaba range in Minnesota will doubtless furnish a striking instance of this process; and some other sources of supply will have to be checked until the first gush of these overwhelming fountains is over. But the moral is, that succeeding

generations are to have abundant opportunities of profitable labor; and we need not complain that we are unable to exhaust or even to exploit at once all the treasure of a continent.

The actual mining industry was admirably represented at Chicago by the obelisk constructed by Dr. David T. Day, statistician of the United States geological survey, which consisted of superposed cubes, each representing the quantity of a given mineral produced in this country per second of time.*

In products and processes, machines, models, and apparatus, both mining and metallurgical, many interesting exhibits were made in the national and State pavilions. The finest, I think, was that of Germany, which in this department, as in so many others displayed an astonishing liberality and public spirit in the admirable contributions which she made to the Exposition. The magnificent trophies and decorative arrangements of iron and steel shapes representing the great works of the brothers Stümm, visible from all parts of the building, deeply impressed the beholder, and prepared him to find in the displays of less imposing proportions, such as the models of collieries, salterns, etc., and the collections of crude and manufactured mineral products, equal evidence of German thoroughness and skill.

It must be confessed that there was no systematic and complete exhibit of mining and metallurgical methods and apparatus, even in the well-ordered German section. From the United States there were a good many (yet, after all, but a few) interesting machines, rock-drills, stamp-mills, etc., some models illustrating recent processes, like the Russell lixiviation or the Hall aluminum process; some applications of electricity, like the Jeffreys coal-cutter or the underground haulage-system operated beneath the building.

The Cape Colony exhibit of demantiferous earth and diamond-washing machinery, might almost be called American; for American engineers are largely engaged in the diamond-mines, and Tiffany's diamond-cutters constituted an American appendage even more interesting than the African show.

There were here and there some good mine-models, such as those of some of the Lake Superior iron-mines, and especially those of the "Copper Queen" in Arizona. But there was not, as there ought to have been, a collection representing all kinds of mine-

*See the appendix to this paper.

models, and permitting their merits for various purposes to be compared.

A full-sized Bleichert cable-tramway, built and operated by an American concern,—the Trenton Iron Company,—attracted much attention as its buckets and carriers traveled to and fro, outside of the building, all day long. There are many of these aerial tramways running in Europe, and not more than fifty in the United States. But they are rapidly coming into favor; and the cheapening of transportation which they will effect, particularly in mountainous regions, is to be no small factor in the prosperity of mining hereafter.

Among manufactured products, nothing in the building was more striking than the cast-iron statuettes and other objects exhibited from Russia. These wonderful castings have all the sharpness of bronze. They are rivaled, if not surpassed, in delicacy by the famous Ilsenburg castings from the German Harz. The Ilsenburg exhibit, however, was unfortunately not in the Mining, but in the Manufactures, building; and the partisans of each of the rival exhibits could only travel from one to the other, and bet dogmatically upon their favorites.

This is a good place to mention the exhibit of the Standard Oil Company, which occupied the gallery across the north end of the building, and constituted one of the most costly, attractive, and instructive displays in the department. It is whispered that the installation cost $70,000; but this is a trifle compared with the expense of furnishing lubricating-oil free, to every machine running within Jackson Park. This latter piece of generosity and advertising skill cost perhaps $150,000.

The scientific arrangement and completeness, no less than the elegance in detail of this exhibit, reflect much credit upon its designer, Dr. David T. Day. True, he is reported to have received *carte blanche* as to expenditures; but it takes genius to use *carte blanche*. In Dr. Day's admirable scheme the geological and geographical conditions, the method and means of production, manufacture, and transportation, and the varied products and applications of petroleum, were presented side by side in comprehensive survey. From the little vial containing a gill of brown oil from the Drake well of 1859 to the big glass bottle (the largest ever blown) containing a barrelful of the crude petroleum of to-day, and surrounded with radiating lines of cases, representing in quantitative proportions the products now derived from that unit of

crude material—the gasoline, naphtha, illuminating and lubricating oils, paraffin (candles, soaps, artificial fruits and flowers and chewing gum), and what not besides,—what an interval of industrial progress! This brief paper of mine skims the surface of things lightly, and I dare not sink it with the weight of statistics; but whoever would form a conception of the magnitude of this industry in the United States has only to multiply mentally by 54,000,000 the products of one barrel of crude petroleum as shown in this exhibit, to arrive at the business of 1892. A simple formula: yet how many of us can multiply by 54,000,000 "in our heads"? Perhaps it is more impressive to say that after deducting the amount exported, we are forced to conclude that every one of us, man, woman, or child, consumes annually, directly or indirectly, in some form, of the long list from gasoline to chewing-gum, half a barrel of petroleum annually!

The Barber Asphalt Company—which has now become the sole owner, as I am informed, of the famous Trinidad deposit—displayed the source, manufacture, and finished form and practical excellences of its asphalt pavement, as well as the extent of its business, in a handsome pavilion, which was never without groups of interested visitors.

As I have remarked already, the exhibits of technical schools were mainly to be found in the galleries of the Manufactures and Liberal Arts building. But the Mining building contained many features of instruction. To say nothing of the relief models of New York State and other regions (and especially the exhibit of Ward's famous Rochester workshop), or the extensive classified mineral collections (especially Mr. George F. Kunz's wonderful array of gems, antiques, and curios), there was a noticeable attempt, on the part of the majority of the exhibitors, to convey quantitative information. The pyramid of the United States geological survey, already mentioned, was a type of such endeavors; and pyramids of cubes representing the amount or value of certain aggregates of mining products, were frequent in the building. The great central obelisk of anthracite, reproducing the exact thickness and structure of the Mammoth coal-bed, was a striking instance. And this prevailing tendency to satisfy the student, as well as amuse or astonish the spectator, rendered the Mining building one of the most profitable departments for repeated visits and leisurely examinations in the whole Exposition.

It is difficult to draw the line separating the class of spectac-

ular exhibits from some of the foregoing. If we may judge from the daily throng of visitors, no other spectacle in the building was so attractive as that of the diamond-washing and diamond-cutting. Yet this was a legitimate exhibit on a working-scale of an actual industry, except, perhaps, that the Zulu on guard was dressed a little more than usual. On the other hand, the silver statue of "Justice," in the Montana pavilion, was purely spectacular. The figure would have looked equally well in spelter, and better in bronze. Nor can it be claimed that the handsome Kentucky castellated doorway, all built of cannel-coal, was indicative of anything in particular as to the qualities of cannel-coal or the resources and industries of Kentucky. Similar remarks might be made concerning the miners' cabins, caverns, and trophies of various kinds which adorned many of the State pavilions, and often revealed the astonishing decorative capabilities, in skillful hands, of unpromising crude materials. In this particular line, however, agriculture unquestionably took the lead at Chicago. The Iowa "Corn Palace" went about as far as art can go in that direction. Such displays are by no means to be disparaged. On the contrary, they confer beauty and interest upon the dull details of fact. But "after the ball is over," they have played their part, and need not be further recalled, save as a pleasant memory.

In conclusion, let me suggest, without much explanation or argument, a few reflections based upon the foregoing outline.

The Hon. Abram S. Hewitt, in his notable presidential address, delivered in 1876 before the American Institute of Mining Engineers, on "A Century of Mining and Metallurgy in the United States," enumerated as the leading epochs of our history in this department, (1) the erection in 1794 of the first steam-engine in America; (2) the rise of gold-mining in the southern States, about 1828; (3) the opening of the anthracite fields about 1820, and the introduction of anthracite as a blast-furnace fuel, in 1839; (4) the use of raw bituminous coal in the blast furnace, in 1845; (5) the development of copper-mining at Lake Superior, in 1845 and subsequent years; (6) the discovery or re-discovery of gold in California, in 1848, followed by the inauguration of gold-mining in Oregon in 1852, Arizona in 1858, Colorado in 1859, Idaho and Montana in 1860; (7) the commencement of the regular production of quicksilver at New Almadon, about 1851; (8) the announcement of the Bessemer process in 1858; (9) the development of hydraulic mining, about 1853; (10) the rise of Lake Superior iron-

mining, about 1856 ; (11) the development of the Comstock lode, in 1859, and the vast extension of the silver-mining industry which has followed ; (12) the innumerable advances in all departments of the iron and steel industry, including the Martin open-hearth process, introduced into the United States by Mr. Hewitt in 1868.

To this list, the orator added a reference to the work of the numerous technical schools of the country, and the potent influence of such societies as that to which his address was delivered.

The rise of the petroleum industry in 1859 is omitted from Mr. Hewitt's catalogue. Perhaps it did not occur to him as strictly a branch of mining or metallurgy. But he includes in his statistical table the product of petroleum ; and it may fairly be counted as not only a branch of mining, but as an epoch-making industry, the timely rise of which, at the time of our Civil War, contributed mightily to the financial strength of our imperiled Union. With this addition, Mr. Hewitt's list is complete.

The seventeen years that have elapsed since he summed up the history of a century have added not a few fresh elements of national strength and progress. From the standpoint of political economy, the most important, I think, is the development of the phosphate industry of South Carolina and Florida, the effect of which has been not only to enrich those States, but to give a vast extension to the southern cotton-belt, and a new lease of life to the declining agriculture of the Atlantic regions, hard-pressed as it was by the competition of newer and richer soils in the West, aided by the cheap transportation of our omnipresent railway-system. This great new industry was represented at Chicago in State exhibits, the significance of which no thoughtful student could overlook.

Another new (though narrowly limited, and hence less profoundly important) industry of the last few years is the mining of fibrous talc in St. Lawrence county, N. Y., and its use in the manufacture of paper. Another is the production of nickel in Canada, and its shipment in large quantities as matte, to be further treated in the United States.

The use of electricity in both mining and metallurgy has made astonishing advances in little more than five years ; and the end is not yet. Its most striking achievement, perhaps, has been the cheapening of aluminum from $12 to less than 50 cents per pound.

Machinery for drilling, coal-cutting, surface-excavating, and especially for the handling of large quantities of bulky crude ma-

terial, like ore, limestone, and coal, has had a remarkable development, both of design and of use, since the Centennial year; and to the consequent increase in the effectiveness of labor, more than to the discovery of new processes or the opening of fields not known before, is due the recent progress of our mining industry. Indeed, such exposures of national resources as that with which the Mesaba iron-range now dominates the iron-ore market would lie unused but for the facilities of excavation, handling, and land-and-water transport, which bring that region into close commercial touch with supplies of fuel and centers of trade.

APPENDIX.

THE details of Dr. Day's ingenious obelisk-pyramid-spire, as furnished by him, are given below. The figures given were obtained as closely as practicable for "round numbers," by dividing the product of 1891 by the number of seconds in a year. For nickel, ozocerite, and iron-ore, the statistics of 1890 were used. The list begins with the minute cube of gold at the tip-top of the structure.

Substance.	Product per pound.	Cubic inches.
Gold	24 grains	0.006
Tin	$\frac{1}{16}$ ounce	0.016
Mica	15 grains	0.02
Nickel	$\frac{1}{8}$ ounce	0.02
Asbestos	$\frac{1}{16}$ ounce	0.036
Aluminum	$\frac{1}{16}$ ounce	0.04
Antimony	$\frac{1}{4}$ ounce	0.06
Bromine	$\frac{1}{8}$ ounce	0.06
Mercury	0.9 ounces	0.1
Ozocerite	$\frac{1}{8}$ ounce	0.1
Silver	1.848 ounces	0.34
Novacutite	$\frac{5}{8}$ ounce	0.4
Corundum	2.3 ounces	1.
Sulphur	1.2 ounces	1.
Chromic Iron Ore	4 ounces	1.7
Infusorial Earth	2.56 ounces	3.4
Fluorspar	10 ounces	5.8
Feldspar	11.4 ounces	7.
Borax	6.7 ounces	7.
Manganese-ore	1.66 pounds	10.4
Flint	1.06 pounds	11.4
Soapstone	1.05 pounds	12.1
Barytes	2.2 pounds	13.8
Zinc	5 pounds	20.
Mineral paints	3.33 pounds	22.
Copper	9.4 pounds	27.
Lead	12.8 pounds	29.8
Fibrous talc	3.33 pounds	33.4
Iron pyrites	8.5 pounds	46.7
Grindstone	5 pounds	64.
Slate	7 pounds	69.
Asphaltum	2.85 pounds	69.
Mineral waters	0.58 gallons	134.
Gypsum	13 pounds	166.
Marble	18 pounds	190.
Potters' clay	28 pounds	293.8
Phosphate rock	41.8 pounds	346.
Sandstone	48 pounds	622.
Salt	88 pounds	1140.5
		Cubic feet.
Cement	98 pounds	1.2
Granite	321 pounds	1.9
Iron-ore	1136 pounds	3.6
Petroleum	72 gallons	9.6
*Natural Gas	892 pounds	11.4
Limestone	1419 pounds	12.8
Anthracite	1.4 tons	31.
Bituminous coal	3.3 tons	96.

* Measured in its equivalent of cannel coal.

THE WORLD'S FAIR AND THE RAILROADS.

By H. G. Prout.

IT is too early to make a just estimate of the part taken by the railroads in the World's Fair. That estimate would include the public service of the railroads in transporting people and material to and from the Fair; the display made by the railroads of objects instructive as examples of skill in the mechanic arts and of growth in refined taste; and, finally, it would include a summing up of the effect of what the railroads did, upon the science and the art of railroading itself.

But we cannot yet find any precise measure of the public service, for we do not know how many World's Fair passengers the railroads carried. In the first place, the railroads have not made up either actual figures or comparative figures of the passenger travel during the World's Fair season; most of the published figures are more or less accurate guesses. In the second place, the passenger movement last summer would have been abnormally small but for the World's Fair. In comparing the passenger movement of this year with other years we shall compare a very dull season, plus the World's Fair travel, with average seasons; so our standard of measurement is shaky. Some time must pass before we see any effect of the World's Fair on design or construction of material or on the methods of operation. Therefore what I shall say must be mostly a statement of impressions rather than a record of demonstrable facts.

What the railroads did was to be seen from two points,—outside of Jackson Park and inside; and I have often thought that their work outside was vastly more important than their display inside the Park. They began with a subscription of about $1,850,000 to the stock and bonds of the Columbian Exposition. This was followed by preparations for the great passenger movement that was to be expected. Unfortunately, the railroads of the United States are not as a rule making money. Year by year the rates fall and the ratio of expenses to earnings rises, in spite of the skill and care with which their affairs are conducted; and so, year by year the returns on railroad property decline. This seems to be the law, and the end no man can tell. But in 1892 and the first months of 1893 the railroads were feeling the effects of foolish financial

legislation as much as any other interest in the land, and the men who were managing those properties were face to face with the hard questions: How much are we justified in spending in preparing for the Fair? How shall we get the cash or credit for such improvements as seem justifiable? As a result of pinching times the preparations of the railroads were mostly in the purchase of locomotives and cars; little extra work was done on yards, tracks, and signals, except in two or three special cases.

As the time approached for the heavy travel more regular trains were put on all the railroads reaching Chicago, and running time was shortened. Thus we find an increase of more than 26 per cent. in the number of regular trains out of New York for Chicago, compared with the same month in 1892; and there were five trains running in 25 hours or less in 1893 against two trains in the former year. A similar increase of service, but relatively less in the number of trains and increase of speed, was made on the railroads reaching Chicago from the southwest, the west, and the northwest.

The most striking feature of this part of the preparation for World's Fair travel was the acceleration of speed between New York and Chicago. The distance is 912 miles by the Pennsylvania, 968 by the New York Central's shortest route, and 976 by the New York Central and the Michigan Central. Seven west-bound trains made this run in 26 hours or less, five in 25 hours or less, and one ran 968 miles, every day, in 20 hours. Altogether this was a magnificent and unequalled group of fast long-distance trains; and this 20-hour train was much the fastest train in the world making anywhere near the same distance. It made 48.4 miles an hour, including all stops, for almost 1000 miles.

Another striking incident of this same movement was the rapid lowering of records of high speeds, the climax being reached in May, when engine 999, of the New York Central and Hudson River road, ran a short distance at the rate of 102.8 miles an hour, hauling a train. The same engine is supposed to have made another run at 112.5 miles an hour; but this last cannot be accepted as a record.

Some of these fast trains have been taken off and the time of others has been lengthened; but the lessons remain. The railroads know, and the public knows, that a 20-hour service between the two greatest cities of the continent is practicable; that there are no mechanical difficulties in running it, day in and day out; that

it is merely a matter of administration and finance. We may expect that with the return of prosperity and brisk travel 20-hour trains will be run on both of the great New York-Chicago roads.

The next stage in the development of transportation to the Fair was the establishment of the long-distance excursion trains, without sleeping cars, and with one fare for the round trip. This was an experiment and there were grave reasons against it. From the start it was doubtful if there would be any direct profit from these trains. The rate must be low and the advertising expenses high, for it was essential, if these trains were run at all, that they should be heavy and run full. These heavy extra trains, run in several sections, would interfere with other traffic and thus reduce earnings and add to cost of working; so the chance was that the direct profit would be more than absorbed by the indirect loss. Furthermore, the half-fare excursions would be sure to take some of the passengers who would otherwise go by regular trains and pay full fare; how many full fares would be lost, and how much entirely new travel would be created by the low rate, no one could even guess. But the railroad officer has no moral right to administer the property which the owners have entrusted to his care for any other purpose than to make money for those owners; it is none of his business to make "popular" experiments merely because they are popular.

Back of all these considerations was one which gave every responsible officer who was fit for his place more concern than all the rest together; that was the greatly increased danger. But the shopkeepers, the hotel-keepers, and all the speculators who had put up the prices of their own wares, the newspapers which had raised their advertising rates, the great mass who wished to travel cheap, and the friends of humanity who put the owners of railroad stocks in a class by themselves,—all these cried out without ceasing that the railroads were ruining the Fair. It is quite true, too, that there were some among the railroad officers who thought that they could make money by a great cheap-excursion movement.

In July the half-fare day-coach excursions were started. In numbers of passengers moved they were strikingly successful. They carried out of New York city only 25,000 people in all; but New York is probably the worst city in the Union to get excursionists from, proportionately to its population. A little reflection will disclose the psychological basis of this curious fact. From other towns, and from the farming districts, the day-coach excur-

sions got immense loads. Trains that left New York in three sections with 500 passengers reached Chicago in eight sections with 2300 passengers. Compare these with some of the excursion trains out of Pittsburgh. For instance, on October 11 an excursion train left that city in nine sections, carrying 2571 passengers for Chicago, and taking up more on the way. On October 21 another train ran out of Pittsburgh in eight sections, with 3575 passengers. There appears to be no record of the number of people taken into Chicago by these two wonderful trains. It will be observed that the heavier of the two averaged 447 passengers to the section. A "section" is of course a complete train in itself, but the eight or nine sections are run on one time schedule, as one train, so far as the time-card goes. Now we have a record of a still more remarkable train of but one section. That ran out of Pittsburgh on August 16 and consisted of one engine, one baggage-car, and eighteen coaches, and carried 912 passengers. When one thinks of the awful consequences of wrecking such a train some of the dread that operating officers have of excursions may be understood.

It is too early to more than guess as to the profit of the excursion trains,—and indeed we shall never know it exactly, for reasons that I have suggested above. One general passenger agent, who was among those who urged the reduction of rates, is now sure that his road lost money by the excursion trains, and yet it had no accidents. Another, who resisted the movement, and wanted rates kept up, is sure that his road made money out of its very heavy excursion business.

I shall not attempt even a guess at the general increase of passenger movement during the World's Fair, for it might be very misleading. I will give only a few examples that will suggest the magnitude of the movement. The total of passengers out of New York city for Chicago, for the six months, was close to 137,000, and the increase over the same six months in 1892 was 357 per cent. That did not, however, give any approximate notion of the increase in the trunk-line territory, for many people went to New York from neighboring towns, and from Europe, to begin the journey. One of the trunk-lines estimates its increase in passengers carried, due to the World's Fair, at less than 1 per cent., not including in the comparison the commutation travel in either year. This is one of the great through lines from Chicago to New York, running through a rich country with many prosperous towns on its lines, and with numerous branches and tributary lines covering a great territory

either side of its main stem. Its experience will at least suggest the effects produced in all the area outside of a circle with a radius of say 300 miles, of which Chicago is the center. Absolutely, a great many passengers moved toward Chicago, from all that vast outside area; relatively, the movement there was trifling, for it must be understood that we are dealing with immense figures. The passengers carried in the United States in 1892, by the steam railroads, leaving out the elevated railroads of New York, were about 576,000,000. Or for six months, we may say they were 288,000,000; an increase of only 1 per cent. would be 2,880,000 passengers.

As we approach Chicago the movement of the people increased. On one division of one of the trunk lines, being the link that begins 500 miles and ends 300 miles from Chicago, the through business increased 178 per cent., which means that the total passenger movement on that division increased more than 80 per cent. over the normal. That was enough to cause an average increase of about 56 per cent. in the number of through passenger trains. One need not have much familiarity with railroad working to realize that on a line already busy such an increase means an enormous addition to the work to be done by all hands. But it is only at Chicago itself that we get the really colossal figures. There we find that at one station alone,—that of the Chicago and Northwestern,—the number of passengers handled, in and out, in the six months was 7,859,000. The loaded cars, in and out, were 182,000; the trains run were 50,500. Unfortunately, the company has compiled no figures comparing this year with last. On "Chicago day," October 9, this company took in and out of the Wells-street station, 80,828 people, and on the three days, October 7–9, the aggregate was 205,228 people, in and out. The reader will understand that all of those people had to cross the city and get to and from the Fair by some other conveyance.

Of course the Illinois Central was more affected by the World's Fair than any other one of the great Chicago roads, and more than all of the rest of them put together. That road not only carried people to Chicago by its own lines from New Orleans, St. Louis, and Sioux City, but delivered to the Fair many of the passengers brought into the city by the other railroads and carried back and forth a never-ending stream of people living in the city itself. The opportunity was great and the management of the railroad met it with wisdom, courage, and high technical skill. Perhaps one

result will be a long truce in the perpetual warfare that rages between this railroad and the people of Chicago.

The Illinois Central is said to have handled on all its Chicago trains,—that is, through trains, suburban trains, and special World's Fair trains,—in and out, a little over 19,000,000 passengers. That is Chicago business alone, be it observed. But in 1892 the total passenger business of the road, covering all its lines, was a little less than 12,000,000 passengers carried; or in half the year it was, say, 6,000,000. The increase in passengers moved must have been something more than 13,000,000, or 217 per cent. Of course the increase in passenger earnings will be nowhere near this, for the new business was very short trips at low rates. But as a feat of railroading it was magnificent. The company spent in preparation directly and indirectly over $2,000,000, not including its great new terminal station. I say directly and indirectly, for much the greater part of this expenditure is a permanent and valuable investment. The one item of raising the tracks for 2½ miles, over thirteen city streets, cost $1,260,000, and that permitted the running of express trains at high speeds, without stop, from the heart of Chicago to the Park entrances. The tracks were covered with an admirable system of block-signals, and special ticket-booths were provided, so that great crowds could be served with the least possible delay. Three hundred special cars were built, with cross-seats, and open sides, and a train of these cars carrying 1000 people could be stopped, emptied, and started again in thirty seconds. These trains alone handled nearly 900,000 people during the Fair, and it was done with astonishing speed, comfort, economy, and safety. Indeed, we are told that of the 19,000,000 passengers carried by the Illinois Central during the six months, not one was killed and but five were injured, and they were injured through their own carelessness. On the whole this performance, the preparation for it, and the results, made up one of the most valuable "exhibits" of the Fair, and one which adds to the glory of American railroading.

We will return for a moment to the general topic of the transportation of passengers to Chicago. What I have said of the increase in the numbers carried will give a wrong impression if we do not remember that much the greater part of this increase was concentrated in the last two months. That was what made the trouble, added to the danger, and reduced the profits. Up to the beginning of September the travel was but moderate, there was no

discomfort, and there were no unusual accidents; but in September and October the crowds moved, trains were overfilled, the delays were great, and there came an appalling succession of accidents which swept away profits and humiliated every American who is proud of his country. The record will stand to the everlasting discredit of our methods. That part of the story need not be retold; it still burns in our minds. The misery of it is that it was foreseen from the beginning.

But how could it have been avoided? First, by better signaling, more and better disciplined men, and closer supervision of all the details of operation; second, by not trying to do so much work with the means at hand. The want of money came in to limit closely the first means. Very few of the railroads of the United States have yet felt able to work their lines under any block system, and in the year or two just preceding the World's Fair they were poorer than ever. Trained and disciplined men and competent officers are a question of time as well as of money; they cannot be picked up in the streets. So it seemed to be a physical and financial impossibility to prepare the railroads for a greatly increased passenger business,—that is, to prepare them to handle it with the same punctuality, comfort, and safety that are had with the normal traffic. The second precaution against accidents was, then, the one to be taken to discourage a congestion of traffic. The obvious way to do this was to reduce fares in the first weeks, while traffic was light, and to put them up later, and to let it be known from the start that they were to be put up; for history taught that the last weeks would be the weeks of the greatest attendance and of the heaviest travel. The railroads did exactly the reverse. They kept rates up at first, while people needed to be stimulated to move, and reduced them later, when all the world had got ready to go. This to my mind is the greatest of all the lessons of the Fair for the railroads, if not for the public.

Finally, what has been the financial gain to the railroads from the World's Fair travel? I began by saying that most of what I write here must be a statement of impressions rather than a record of demonstrable facts, but I will hazard the guess that to a few of the roads there has been considerable profit, to most of them none, to some of them actual loss.

We may conclude this part of the subject with the words of a railroad president who has been for thirty years an active operating officer: "I am very proud of the grand exhibition at Chicago.

I delight in its memories. Its realities were infinitely beyond my poor conception of its possibilities ; and dreadful and humiliating as is the record of railroad disaster, the handling and comfortable accommodation of that happy multitude deserves to rank among the marvels."

And so we come, rather late, to the second general division of my subject,—what the railroads did inside the Fair. My first impressions of the showing made by the railroads themselves and by those who have things to sell to the railroads was that, while there were some displays that were magnificent, many that were most pleasing to the esthetic sense and instructive to the mind, there were also many that were misleading to the uninformed, and some that were mere trash. As I saw more and learned more, this impression changed in degree, but not in kind. I thought more highly of the good exhibits and more leniently of the bad ones. I found that even the poorest of them interested, and perhaps instructed, many visitors, and there seemed to be few that ought not to have been admitted. The one great defect in this part of the Fair was the lack of coördination and completeness in collection and display. It was fragmentary. Many of its parts were admirable, some of them very remarkable; but the man who wished to study a subject through found the illustrations of it troublesome to follow up, and usually not at all comprehensive.

There were some grand exceptions to this. The collection made by the Baltimore and Ohio railroad was one of these exceptions. It was designed to show the historical development of the railroad, and the conception was carried out with something more than liberality of expenditure. Anybody can spend money; but the Baltimore and Ohio people did this with judgment and pains and learning ; and one of the most important events in the history of mankind was unrolled and illuminated before our eyes. A practical philosopher of our own country,—one who has not only thought but worked to great purpose,—once said that Sir Henry Bessemer had done more than all other recent forces to break down the aristocracy of England and to do away with class distinction. He meant that Bessemer's labors and discoveries had done this by lowering the cost of transportation. I am not quite sure that our philosopher did not exaggerate the importance of one element in this process, but there can be no doubt that one of the profoundest industrial revolutions that the world has ever known has taken place almost within our own generation and

almost without our realizing it; and it was the growth of the machinery by which this revolution had been made that the Baltimore and Ohio exhibit undertook to show. The success of its undertaking was great.

I should say that the next individual exhibit in importance was that of the Pennsylvania railroad, which was designed to show not the development of the railroad as a whole, but the development of one great, characteristic American system of railroads. And here again a liberal use of money was supplemented by a liberal use of sense and diligence, and the visitor could see here the whole history of the building of a great railroad company.

It would take too much space to mention the other meritorious exhibits of the various railroad companies. I have mentioned these two only because they were of such preëminent excellence; but there were several others that were very fine. But there was one exhibit which, while not in the Transportation Department, and while classed as a concession rather than as an exhibit, was of such importance to the art of railroading that it should not be passed without mention. That was the installation of the "Intramural" electric railroad. The successful operation of that railroad was very suggestive to railroad-men, particularly to operating officers and to civil and mechanical engineers, and it is bound to have an effect on future practice. It showed some of the possibilities of electric traction in crowded cities, and has suggested to many minds a solution of what has within a few years come to be known everywhere as the rapid transit problem.

But let us return to the halls of the Transportation building. As a whole the display there of illustrations of American railroading was comprehensive enough and characteristic enough to be of real value to the student. Much of the material that was exhibited was not typical, but was fixed up for the occasion. Nevertheless, there was enough that was actually characteristic to give to foreigners and to Americans not familiar with the details of railroading, a just idea of American practice. The locomotives, for instance, that were exhibited were numerous and typical, so far as the United States goes, but the representation from abroad was disappointing. Still, the foreigner had a capital chance to learn about American locomotives, and the American had some opportunity to compare those with which he is familiar with those used abroad. The most casual observer could not fail to notice the great weight and the simplicity of the American locomotive, the

extreme complication of the French, the tidy, thoroughly mechanical aspect of the English, and the simplicity (among the foreign engines) of the German locomotives. It was a great school for the younger mechanical engineers and locomotive-men of the railroads, and will doubtless bear valuable fruit, particularly in matters of design, construction, and finish of details.

We may say of the display of cars much the same that we have said of that of locomotives. The American showing was large and very handsome, and the foreign showing, while handsome in the specimens sent, was disappointing in quantity and variety. Nevertheless, here, too, the visitor had an opportunity to make some valuable comparative studies. He had an opportunity to learn that grace in form may be combined with the highest utility in the design of the most matter-of-fact details of a railroad car; and I am inclined to think that one of the greatest benefits of this comparative exhibition will be in the development of a just taste in design. Our own designers had an opportunity to see what could be done with line and proportion and honest material honestly treated. They had a chance to see how vulgar our overloaded, embroidered, and bedizened cars often are, and what a poor substitute tawdry decoration is for competent and sincere work in elementary design. After all it was the old lesson that the ultimate triumph of any piece of human work, whether it is a picture, or a book, or a building, or the policy of a statesman, is simplicity.

It would be too great a task and would take too much of the space of THE ENGINEERING MAGAZINE to attempt to give an estimate of the value of the exhibits in all the multitudinous subdivisions of railroad organization. The showing of air-brakes, of signaling in various forms, of wheels, axles, brake-shoes, track, and all the thousand-and-one details which go to make up a railroad, was worth weeks of study. It is safe to say that many inventors, designers, constructors, and operating officers have moved up a step as the result of the Fair. Their future work will go on from a higher plane. Doubtless some general passenger agents have learned a lesson or two, and perhaps even the great public will have a more correct notion than it ever had before of what railroads ought and ought not to try to do. Altogether, this World's Fair was not an epoch in the science and art of railroading, nor should we expect a revolution as a consequence of it; but it has been an immense stimulus to thousands of minds which are every day creating that science and developing that art.

DESIGNERS AND ORGANIZERS OF THE FAIR.

By Edward C. Shankland.

IN the summer of 1889, when each of several cities of the United States was striving for the honor of being chosen as the site of the World's Columbian Celebration, it was resolved by the city council of Chicago that that body, in connection with the mayor, should appoint "a committee of 100 citizens to take preliminary steps towards securing the location of the World's Fair in Chicago." Mayor Cregier decided that 100 was not enough, and at the next meeting of the Council presented a list of 256 names, which was promptly confirmed.

In August an executive committee of thirty-five was appointed out of this number. This committee immediately formed itself into a company known as the World's Exposition of 1892, to have a capital stock of $5,000,000, and applied for articles of incorporation under the laws of the State of Illinois. The signers of this application were Ferd. W. Peck, DeWitt C. Cregier, George Schneider, Anthony F. Seeberger, W. C. Seipp, John R. Waller, and E. Nelson Blake. About this time E. T. Jeffery, a well-known railroad-man, and Octave Chanute, an eminent civil-engineer, were sent to Paris to report on the exhibition there in progress. The next thing to be done was to raise the $5,000,000 of stock. The finance committee, of which Lyman J. Gage was chairman, worked hard and succeeded in raising $500,000, but after that subscriptions came in so slowly that the finance committee became alarmed. The whole matter was then put in the hands of Otto Young, who had expressed his belief the money could be raised—and his willingness to undertake the work. He formed a sub-finance committee, composed of himself, B. R. De Young, and D. K. Hill. Mr. De Young was soon succeeded by H. H. Kohlsaat. These three men devoted themselves night and day to their herculean task, and by January 9, the day on which Chicago was to plead her case before Congress, they had secured pledges for $5,000,000, and had won their cause. While Mr. Young and his associates deserve especial praise for their efforts, every one connected with the organization at this time devoted himself to it unselfishly, to the neglect of his own affairs. Mr. Ferd W. Peck worked mightily in the cause, as did Thomas B. Bryan, R. A. Waller, and Robert

Lindbloom, of the committee on agitation, and E. F. Cragin, secretary of all the committees.

On March 26, 1890, Congress—having in the meantime stipulated that Chicago should raise an additional $5,000,000, making a total of $10,000,000—passed a bill making Chicago the site for the World's Columbian Exposition. On April 4 a meeting of stockholders was held, and forty-five directors were elected. L. J. Gage was elected president, A. F. Seeberger, treasurer, and W. K. Ackerman, auditor. Benjamin Butterworth was the first secretary; later, H. O. Edmonds took his place. On April 9, 1890, a license of incorporation was received from the State legislature. In May a National Commission was appointed by President Harrison, composed of members from each State in the Union, and it elected Thomas W. Palmer president, and George R. Davis director-general. The duty of the National Commission, known as the World's Columbian Commission, was to handle the whole question of exhibits, and to deal with the foreign governments. The local directory, known as the World's Columbian Exposition, prepared the site and put up the buildings. This great work devolved directly upon the grounds and buildings committee, and the men who as members of this committee contributed so largely to the success of the Fair are E. T. Jeffery (chairman), L. J. Gage, H. B. Stone, C. H. Schwab, J. P. Ketchum, R. A. Waller, and A. W. Sawyer (secretary).

To show the commercial or business standing of the gentlemen in whose hands was placed the financial organization of the Fair, it may be mentioned that of the above list Mr. Peck is a large owner of real estate in Chicago; Mr. Seeberger is a wholesale hardware dealer; Mr. Seipp is a brewer; Mr. Gage is the president of the First National Bank of Chicago; Mr. Young is a merchant and the owner of much valuable real estate; Mr. Hill is a member of a clothing firm; Mr. Kohlsaat is the editor of the Chicago *Inter-Ocean*; Mr. R. A. Waller is a real-estate owner and a leading insurance-man; Mr. Ackerman is a past president of the Illinois Central railroad; and Mr. Stone, formerly a railroad president, is general manager of the Chicago Telephone Company.

The first question for the directory to settle related to the site. The north and west sides of the city each offered a site, and the south side two. Then the lake front had many supporters. Each site was warmly defended, and a vigorous fight ensued, which was finally ended by the selection of Jackson Park, with the lake-front

as an entrance. On August 20, 1890, the grounds and buildings committee appointed F. L. Olmsted & Co. consulting landscape architects, and, on September 2, Burnham & Root as consulting architects, and A. Gottlieb as consulting engineer. In October Mr. Burnham was made chief of construction. The consulting landscape architects, the consulting architects, and the consulting engineer formed an advisory board, Mr. Burnham being chairman. This board at once started to work up a general plan of the Exposition, the directory giving them the number and size of the buildings required. From sketches made by H. S. Codman, Mr. Olmsted's partner, Mr. Root drew on brown paper, with a lead pencil, a rough sketch of the whole scheme. This was submitted to the World's Columbian Exposition, and adopted December 1, 1890.

Upon the approval of the World's Columbian Commission of the action of the World's Columbian Exposition, the order was given to proceed with the design. Then came up the question of the selection of the architects. Mr. Burnham insisted that there should be no competition, but that he should be allowed to select the men he deemed worthy from the whole country. This was finally adopted by the grounds and buildings committee in the face of strong opposition, and they authorized Mr. Burnham to select five architects outside of Chicago to design the five principal buildings around the Court of Honor. Later he was directed to choose five from Chicago to design the other buildings. This one act of Mr. Burnham, more than any other in its history, made the Fair an architectural and artistic success.

The list of architects chosen by Mr. Burnham, with the buildings as afterwards apportioned to them, follows: Richard M. Hunt, Administration building; Peabody & Stearns, Machinery Hall; McKim, Mead & White, Agricultural building; George B. Post, Manufactures and Liberal Arts; Van Brunt & Howe, Electricity; S. S. Beman, Mines and Mining; Adler & Sullivan, Transportation; Henry Ives Cobb, Fisheries; Burling & Whitehouse, Festival Hall; and Jenney & Mundie, Horticultural building.

These gentlemen, with the consulting board, and Augustus St. Gaudens, the sculptor, met on January 10 in Chicago and agreed on certain rulings as to heights and other conditions which should govern all the main buildings. Afterwards it was determined to select an architect for the Woman's building by means of a competition confined to women. Miss Sophia G. Hayden was awarded the first prize, and was employed as the architect of the building.

It was understood that the architects should not furnish any constructional plans, but that all of the construction should be designed by Mr. Burnham's staff. On February 20, 1890, the architects met again for consultation, each one having his sketches, which he submitted for the criticism of the others. It now became necessary for Mr. Burnham to organize his staff and to form an estimate of the work to be done. I cannot do better than quote from Mr. Burnham's report to the World's Columbian Exposition :

> Roughly speaking it consisted of reclaiming nearly 700 acres of ground, only a small portion of which was improved, the remainder being in a state of nature, and covered with water and wild-oak ridges, and in twenty months converting it from a sedgy waste by the borders of an inland sea, into a site suitable in substance and decoration for an exposition of the industries and the entertainment by the republic of representatives of all the nations of the world. On its stately terraces a dozen palaces were to be built,—all of great extent and highest architectural importance,—these to be supplemented by 200 other structures, some of which were to be almost the size of the Exposition buildings themselves; great canals, basins, lagoons, and islands were to be formed ; extensive docks, bridges, and towers to be constructed. The standard of the entire work was to be kept up to a degree of excellence which should place it upon a level with the monuments of other ages. It meant, in short, that an organization must be quickly formed which should associate the ablest architects, landscape designers, painters, sculptors, and engineers of the country. Previous to this time it had not been possible to form a proper corps of expert men to handle the work. The opportunity for gaining honorable distinction, however, made the duty of choosing the men for the force comparatively easy, and in a very short time after the plans were finally adopted, the following were on the field of action, working with one object—the welfare of the great enterprise :
>
> Charles B. Atwood, Designer in chief.
> William Pretyman, Director of color.
> E. G. Nourse, General engineer.
> Frederick Sargent, Electrical engineer.
> J. C. Slocum, Mechanical engineer.
> W. S. MacHarg, Sanitary and water engineer.
> John W. Alvord, Engineer of grades and surveys.
> Ernest R. Graham, Assistant chief of construction.
> Rudolph Ulrich, Landscape superintendent.
> Dion Geraldine, General superintendent.
> W. D. Richardson, Superintendent of exterior covering.
> F. O. Cloyes, Chief draughtsman.

Later Mr. Slocum and Mr. Sargent resigned, and R. H. Pierce was made electrical engineer, and C. F. Foster mechanical engineer. In the summer of 1891 Mr. Gottlieb, chief engineer, resigned, and Edward C. Shankland took his place. W. H. Holcomb was made general manager of transportation, and E. G. Nourse became assistant general manager. Mr. Pretyman resigned in May, 1892, and Frank D. Millet became director of decoration. Colonel

Edmund Rice, U. S. A., took control of the guard in May, 1892. Marshal Edward Murphy took entire charge of the fire department in December, 1892. C. D. Arnold was made official photographer; Dr. John E. Owens, medical director, and F. J. Mulcahy, purchasing agent. Mr. Geraldine resigned in the fall of 1892. Later, upon the completion of his duties as superintendent of exterior covering, W. D. Richardson was made general superintendent of buildings.

To F. L. Olmsted & Co., and especially to Mr. Codman, who gave his personal attention to the work, belongs the credit for the general scheme and design. Mr. Codman died before the opening of the Fair, but he lived long enough to see his plans practically completed, and to know that the Exposition would be a grand success, and largely through his own efforts. Mr. Root died in January, 1891, shortly after his sketch had been adopted by the grounds and buildings committee, but his sketch has been largely followed and his genius has been felt throughout the enterprise.

Mr. Burnham needs no word of praise from me. His magnificent courage, his untiring energy, his loyalty to his staff, would have made a success of the enterprise had the obstacles been even greater than they were. He is the man who built the Fair, and the glory of his fame will but increase when the history of the Exposition comes to be written. His assistant, E. R. Graham, presided at the meeting of the staff each morning. His grasp of affairs was remarkable, and the amount of work done by him prodigious. M. B. Pickett, at first private secretary, afterwards secretary of works, by his ability, tact, and capacity, was of great assistance.

One of the earliest questions discussed was that of transportation. Upon it the location of the site largely depended. W. H. Holcomb, general manager of transportation, aided by E. G. Nourse, assistant general manager, solved successfully the very complicated problems which arose. It was also made Mr. Holcomb's duty to receive the exhibits from the railroads, and put them on the spaces allotted to them, and take care of the empty packing cases.

F. Sargent laid out the power-plant, and located the dynamos. He proposed the scheme for general electric distribution. This scheme consisted of an underground tunnel for running the wires connecting the several buildings, and a general distribution on the Intramural railway, and from the main subway, in small ducts, through which the wires were drawn. This was modified by running a subway of underground ducts to carry the wires originally

intended to be put on the Intramural railway, as this was found not to be feasible.

Luther Steringer was retained by the Exposition as consulting electrical engineer on illumination, and to him belongs the credit for the coronas in the Manufactures and Liberal Arts building, for the design of the electric fountains, and for the interior illumination of the Administration building and the galleries of Fine Arts. Aside from this the whole credit for the successful installation of the vast electric plant used by the Exposition belongs to R. H. Pierce, electrical engineer. Only those on the grounds know how serious were the problems or how many were their complications.

C. F. Foster did not come to the service of the Exposition until within two-and-one-half months of the opening. Most engineers, looking over the ground when he took hold, and seeing the lamentably incomplete condition of the plant, would have refused the position, realizing the almost hopelessness of bringing order out of such chaos, but Mr. Foster did not hesitate. It kept him hard at work night and day, but he had the satisfaction of being eminently successful in his work, and the Power Plant of the Exposition is a monument to his skill and perseverance.

It was W. S. MacHarg's duty to design a system of water supply, sewerage, and drainage for the park, equal to a city of 250,000 inhabitants. Mr. MacHarg brought to his work a skill born of large experience. He used the Shone ejector system on a much larger scale than it ever had been done before, and his sewage cleansing works and crematory have been highly praised by eminent sanitary engineers who have visited the Fair.

When it was determined to make the exterior of all the buildings of staff, the construction department entered an entirely new field. Staff, or rather a stucco, had been used, but it had never been attempted before to completely cover the exterior of large wooden buildings with it. Mr. Burnham made a happy choice when he put W. D. Richardson, who had formerly been a contractor of large experience, in charge of this work. Experts who were called from Boston and New York could make no suggestions of value as to the methods to be employed, and Mr. Richardson had to determine for himself the best means for doing the work. That he succeeded will be questioned by no one who saw the buildings, with their statues, and the animal figures on the bridges and terraces, all constructed under Mr. Richardson's supervision.

The work done by J. W. Alvord in his department of surveys

and grades, was admirable, and the completeness and accuracy of his work made it of the greatest value during the stormy period of construction. Mr. Geraldine can have no better praise than is afforded by the work done at the park during the time he was general superintendent.

The amount of work done by Mr. Cloyes and his force of architectural draughtsmen and the engineer draughtsmen who worked in conjunction with them, and in the wonderfully short time in which the plans were gotten out, can best be told from the record of contracts let. His department was organized April 1, 1891. By July 1 all the constructional and architectural plans had been made, and contracts let on the Administration, Horticultural, Manufactures and Liberal Arts, and Mines and Mining, Transportation, and Women's buildings, and the others followed rapidly.

In April, 1891, Mr. Gage declining a renomination, W. T. Baker was elected president. He was reëlected the next spring, resigning in August, 1892, on account of ill health, caused by the excessive labor he had done in this work. Mr. Baker was president practically during the whole period of construction, and he worked night and day for the success of the Exposition. H. N. Higinbotham succeeded him as president, and remained in office until the close of the Fair.

Each architect was allowed to select the sculptor for his building, and he, under the direction of the architect, and with Mr. St. Gaudens as advisor, designed the sculpture for that building. The list with their buildings is as follows:

Philip Martiny, Fine Arts and Agricultural buildings.
L. G. Mead, Main pediment, Agricultural building.
J. J. Boyle, Transportation building.
Karl Bitter, Administration building.
M. A. Waagen, Machinery Hall and Colonnade.
E. C. Potter and D. C. French, Peristyle.
Lorado Taft, Horticultural building.
Miss Alice Rideout, Woman's building.
A. P. Proctor and T. Baur, Lions on Art building.
A. P. Proctor and E. Kemys, Animals on bridges.
D. C. French, Statue of "The Republic."
Carl Rohl-Smith, Statue of Franklin.
J. Gelert, Figure of "Neptune" on rostral columns.
Frederick MacMonnies, MacMonnies fountain.
Augustus St. Gaudens, Statues of "Diana" and Columbus.

When Mr. Millet was made director of decoration he immediately called to his aid a distinguished coterie of artists: Reinhart,

Simmonds, Reid, McEwen, Melchers, Blashfield, Cox, Shirlaw, Beckwith, Earle, Garnsey, Maynard, Sullivan, Dodge, Coleman, Weir, Louis Millet, and others. The Exposition owes much to Mr. Millet, and we of Mr. Burnham's staff have formed a friendship for him which time will not efface. He brought to us a mind trained in many channels, and a rare fund of practical common sense. He criticised us fearlessly, yet he was a generous true friend. He became one of us, and his zeal in the work was second to none. It was a liberal education to have been intimately associated with him.

I have stated that the World's Columbian Commission had in its charge the whole matter of securing and arranging the exhibits. Before the departments were organized a great deal of work in this line was done by Major Moses P. Handy, of the department of publicity and promotion. Walker Fearn, chief of the department of foreign affairs, conducted all the correspondence with foreign governments, and through his department was made all the assignment of space to foreigners.

As soon as Director-General Davis had organized his staff, composed of the chiefs of the different departments, each chief was given entire charge of securing the exhibits for his building, and assigning space for the same. W. I. Buchanan, chief of the department of agriculture, did all the work of getting together his very fine exhibit. He had charge also of the department of live stock, in which he was assisted by Mr. Garland, and the department of forestry, in which he had Mr. Evans as his assistant. To L. W. Robinson, chief of the department of machinery, belongs the credit of securing and installing the machinery exhibit. The incessant labor performed by F. J. V. Skiff, chief of the department of mines and mining, resulted in one of the most valuable and interesting exhibits on the grounds—that in the Mines building.

Dr. Allan Hornsby, assistant chief of the department of electricity, attended to all the details of securing the exhibits in his building, consulting with Chief Barrett in the general arrangement of the exhibits, and in negotiations with the more important exhibitors. Dr. Hornsby visited Europe in the interests of his department. James Allison, chief of the department of manufactures, aided by Frank Williams, collected the enormous exhibit in the Manufactures and Liberal Arts building. In the department of liberal arts Dr. Selim H. Peabody organized and planned the entire exhibit. Two bureaus of this department were installed in

the Anthropological building, viz.: the bureau of charities and corrections, in charge of S. S. Rosenau, and the bureau of hygiene and sanitation, in charge of Dr. W. F. Brewer. Professor F. W. Putnam, chief of the department of ethnology and archæology, installed and arranged the exhibits in his department, although he had a number of distinguished assistants collecting for him in all parts of the world. Professor Putnam also collected the ethnographical exhibits in the Midway Plaisance and the cliff-dwellers and native American Indian exhibit at the South Pond.

William E. Curtis personally collected the very remarkable and interesting La Rabida exhibit. Mr. Curtis, as head of the Latin-American Bureau, represented the department of foreign affairs in the Madrid Exposition of 1892, for the purpose of securing the Columbus relics from Spain.

Willard A. Smith, chief of the department of transportation, had charge of the magnificent exhibit made in his building, being assisted by Lieutenant Baker, U. S. N., who had charge of the marine division. In the department of horticulture J. M. Samuels, the chief, was most fortunate in having for his assistant in charge of floriculture John Thorpe, to whom is due the credit for collecting and installing this exhibit. Mr. La Rue was in charge of the division of viticulture. Captain Collins had entire charge of the organizing and installing of all of the exhibits in the Fisheries building. Captain Collins was ably assisted by Mr. W. P. Seal.

Mrs. Potter Palmer, president of the board of lady managers, with the invaluable assistance of Mrs. Starkweather, collected the exhibit of woman's work in the Woman's building.

Professor Halsey C. Ives, assisted by Miss Sara Hallowell and Charles M. Kurtz, collected and installed the Fine Arts exhibit. Professor Ives visited Europe in the interest of his department.

The United States government exhibit, the finest ever made, and in many respects the most interesting and valuable of the whole Exposition, was collected and installed by the following:

Department of Agriculture: Edwin Willits, assistant secretary of the national department.

Department of State: S. A. Brown, chief clerk; W. E. Curtis, Bureau of American Republics; W. W. Rockhill, chief clerk.

Treasury Department: A. B. Nettleton, assistant secretary; F. A. Stocks, chief clerk.

War Department: Major Clifton Comly, U. S. A.; Captain Frederick Aytoun, U. S. A.; Captain A. H. Russell, U. S. A.

Navy Department: Commodore R. W. Meade, U. S. N.; Lieutenant Commander E. D. Taussig, U. S. N.

Post-Office Department: A. D. Hazen, third assistant postmaster general.

Department of the Interior: H. A. Taylor, commissioner of railroads; F. W. Clarke, geological survey.

Department of Justice: E. C. Foster, general agent; Cecil Clay, chief clerk.

Smithsonian Institution and National Museum: G. Brown Goode, assistant secretary.

United States Fish Commission: J. W. Collins, U. S. F. C.; Tarleton H. Bean, U. S. F. C.

Secretary and Executive Officer, F. T. Bickford.

The battleship *Illinois* was designed by F. W. Grogan, naval architect.

Respecting the character of men placed in charge of the various departments of the Fair, it may be said that Mr. Buchanan, in charge of agriculture, had been for four years chairman of the executive committee of the Sioux City Corn Palace; Mr. Robinson, chief of machinery, is an engineer in the United States Navy; Mr. Barrett, chief of electricity, is chief of the electrical department of the city of Chicago; Mr. Hornsby, the assistant chief, is a physician and an editorial writer; Mr. Smith, chief of transportation, is the editor of the Chicago *Railway Review;* Mr. Skiff, chief of mining, after many years in Western journalism became engaged in irrigation work; Mr. Allison, chief of the department of manufactures, brought to the work the experience gained in the Centennial Exposition of the Ohio Valley at Cincinnati in 1888; Professor Ives is the director of the art school in St. Louis; Mr. Thorp, of the horticultural department, lives in Flushing, N. Y., and has a world-wide fame as a florist.

All the concessions both in the Midway Plaisance and Jackson Park, before making contracts with the Expositions, had to be approved by the ways and means committee. When the great number of these concessions is considered, it will be seen that an immense amount of labor was performed by this committee, and H. N. Higinbotham (chairman), E. P. Butler, R. A. Waller, Andrew McNally, Adolph Nathan, M. W. Kirk, Washington Porter, and H. H. Hohlsaat devoted a great deal of time to this work, and the great diversity of the attractions, and the profits of the Exposition, show the good results of their efforts.

The limits of this article will not permit giving the names of all who deserve credit in this enterprise. The roster should include all: the engineers, the building superintendents, the draughtsmen, and the office force. Each one worked with all his might, not for self, but for the glory and success of the Fair.

COST AND INCOME OF THE GREAT FAIR.

By Anthony F. Seeberger.

THE magnitude of the World's Columbian Exposition has been a marvel to all visitors, and it will live in history as the most stupendous affair of the kind up to date. When it is considered that this great Exposition was the work of man, one must instinctively speculate at its cost. To say that it required the services of ten thousand men to prepare the grounds and erect the great buildings that have compelled the admiration of every beholder, would not be an accurate statement of the labor necessary to create this Exposition, because it would not include the unnumbered thousands of men and women who were engaged for months and years in preparing the exhibits which the buildings contained.

The approximate cost of erecting the various buildings and the necessary expense of management can be given, of course, and while these figures are colossal in amount, they would seem insignificant, if in an opposite column should appear the actual aggregate which has been expended in order to form the entire exhibition. It would be impossible to give the actual cost in time and money which this Exposition has required from its stockholders, promoters, and exhibitors, but we may omit this unledgered amount and still be overpowered with the figures which are available.

It was said that the great Paris exposition of 1889, which was claimed to have been,—and so acknowledged by everybody,—the very pinnacle of perfection in the way of an exhibition, cost about $8,000,000, and that it would be impossible for America to equal it. Able but pessimistic writers attempted to prove that the population of America, within a radius of say five hundred miles of any city, was not sufficient to support an Exposition of great magnitude, and that visitors from a great distance could not be expected in large numbers.

Premonitory symptoms of cholera, which was to some extent raging in the far east and traveling westward, were urged as a reason why it was not wise to attempt the exploiting of a great international exposition, which should in any way equal the great Paris success. It was claimed that if by any possibility the money could be raised and the people induced to come in any numbers from

COMPARATIVE STATISTICS OF GREAT EXHIBITIONS.

EXHIBITIONS.	Acres covered.	Length in days.	Number of exhibitors.	Number of visitors.	Estimated cost.	Total receipts.
London, 1851	21	144	17,000	6,039,195	$1,460,000	$2,530,000
Paris, 1855	24.5	200	23,954	5,152,330	1,700,000	1,280,000
London, 1862	.....	171	28,653	6,225,000	2,300,000	2,942,410
Paris, 1867	37	117	50,216	10,200,000	4,000,000	2,103,675
Vienna, 1873	40	186	42,000	4,100,000	7,690,000	1,030,000
Philadelphia, 1876	60	....	30,863	9,910,916	8,500,000	3,800,000
Paris, 1878	60	194	32,000	16,032,725	.....	2,531,650
Paris, 1889	1,373	183	60,000	32,354,111	11,000,000	8,380,000

abroad, they would bring with them the dreaded scourge of cholera, which would depopulate the city in which such an exposition was held, and the result would be a stupendous financial failure.

Notwithstanding the discouraging letters and telegrams from abroad, a corporation was formed to do the very thing which so many claimed could not be done, and now that the great Exposition has closed and the chiming bells have played their last tune, while the reverberations are still sounding in our ears, it is interesting to know that not a case of cholera has appeared, and the Exposition has been the greatest success of all the ages.

It is true that the money of the 30,000 stock-holders, who subscribed more than $6,000,000, and the additional $5,000,000 subscribed by the city of Chicago, cannot all be returned; but the contracted debts have been paid, and something will be returned to the patriotic citizens who so generously subcribed to the capital of the enterprise.

In order to have a proper conception of the magnitude of the World's Columbian Exposition, it will be necessary to mention a few facts in connection with previous expositions, that we may have some basis for comparison.

I am unable to vouch for the correctness of figures in the accompanying table, as I have no official reports at hand respecting the various exhibitions.

The total cash receipts of the World's Columbian Exposition, from all sources, and the disbursements, for all purposes, up to and including November 12, were:

Receipts	$33,290,065.58
Disbursements	31,117,353.79

During the month of May, 1893, there were 11,482 persons on the pay-rolls of the company, and their aggregate compensation was $387,499.89, not including about 7000 men employed by contractors.

The receipts and expenses for the six months from May 1 to October 31, inclusive, were:

Months.	Receipts.	Expenses.
May	$ 666,140.61	$593,757.20
June	1,647,644.44	630,595.20
July	1,967,194.84	598,319.97
August	2,337,856.25	569,798.12
September	3,169,938.92	537,566.92
October	4,402,467.35	610,000.00
Total	$14,141,242.41	$3,540,037.41

The average receipts per day during the Exposition period were $89,501.53. The average expenses per day, for the same period, were $18,380.59. The smallest attendance during the Exposition period was on May 5,—10,791, and the largest attendance was on "Chicago Day," October 9,—729,203. The total number of paid admissions for the Exposition period was 21,530,854.

RECEIPTS.

Balance from temporary organization		$ 4,252.64
Instalment receipts on stock		10,516,698.43
Interest on deposits		68,090.50
Received from sale of Souvenir coins	$1,094,144 78	
	1,435,000.00	2,529,144.78
Gate receipts		10,578,146.81
Received from concessionaires		3,384,016.23
Received for sale of bonds		4,444,500 00
Accrued interest on bonds		30,976.52
Miscellaneous receipts from sundry sources, comprising receipts for power and light, photographs, passes, badges, etc.		1,734,239.67
Total receipts		$33,290,065.58

Included in above total of disbursements are the following items, which should be specially mentioned:

Landscape gardening	$ 485,669.97
Landscape architecture	23,064.27

Dredging, filling, and excavating	$ 614 926.36
Coloring and decorating	382,544.84
Draughtmen's wages	178,159.94
Decorations	113,956.02
Electric plant	1,097,757.03
Interior docking	268,024.81
Grading and surveying	147,730.24
Piers and breakwaters	308,019 90
Roadways and sidewalks	346,246.92
Sculpture modeling	375,310.67
Statues	230.172.28
Superintending construction	188,548.28
Water and sewerage	926,030.77
Horses, wagons, harness, etc	38,170.82
Administration building	463,213.45
Agricultural building	659,294.61
Mines and Mining building	265,473.96
Horticultural building	296,399.93
Transportation building	554,041.20
Terminal railway-station	229,524.00
Grand fountains	122,500.00
Anthropological building	107,438.52
Music Hall, Casino and Peristyle	373,418.74
Art building	758,578.20
Art Institute	200,000.00
Fisheries building	234,733.29
Machinery Hall	1,225,515.98
Manufactures building	1,799.837.87
Public comfort	26,936.45
Grounds and buildings office	101,492.21
Convent of La Rabida	24,621.61
Shoe and Leather Trades building	93,243.76
Forestry building	82,708.59
Women's building	138,769.10
Electricity building	447,397.70
Elevation of the Illinois Central tracks	250,150.00
Furniture for buildings	108,552.39
Railway tracks	407,423.15
Exposition symphony orchestra	135.589.10
Fire protection	131,468.52
Foreign agents	118,045.35
Insurance	138,963.40
Installing exhibits	294.599.97
Operating power-plant	266,126.60
Police protection	885,558.90
Salaries of clerks	387,001.88
Salaries of officers	323,685.48
Salaries of musicians	128,674.85
Salaries of architects	133,830.23

It is proper in connection with a statement of this kind to mention the following appropriations made in the interest of the Exposition:

From Foreign governments.....	$6,571,529 00
Appropriations by different States of the Union..	6,020,850.00
Appropriations made by the United States government (not included in any of the above figures)	2,668,875 00
	$15,251,254.00

It would be a very interesting item for future reference if the actual amount expended by foreign and American exhibitors could be added to the above figures, but if any such estimate has been made, it has not come to my notice. Of course this will be approximately obtained.

ELECTRICITY

Conducted by Franklin L. Pope.

A DISTINGUISHED European electrical engineer, who availed himself of the opportunity afforded by the Columbian Exposition to visit the United States and to make a somewhat extended investigation of our electrical industries, has observed that there was really very little at the Fair which should be either novel or surprising to the American electrician, and that, for his own part, while he was much interested in what he saw there, he was far more surprised at the actual technical and industrial applications which he found in various places throughout the country. While this view of the matter is, in a broad sense, not altogether an incorrect one, yet certain exceptions thereto, and these by no means unimportant, must be admitted. The operation of nearly all the moving machinery outside of Machinery hall by means of electrical energy, involving the transmission and utilization in various ways of perhaps 5000 horse-power, furnished an object lesson in the way of the electrical distribution of power such as has never before been witnessed in the history of the world. The extraordinary flexibility and adaptiveness to every possible condition of which electrical energy is capable, was admirably exemplified by the comprehensive exhibit of the capacities of the Tesla polyphase system made by the Westinghouse company. On the other hand, the great rival of the Westinghouse, the General Electric Company, must be admitted to have especially distinguished itself in its practical demonstrations of the modern possibilities or rather actualities of electrical transportation. The Intramural electric railway,—the first thoroughly successful attempt, on a large scale, to adapt electricity to the onerous requirements of modern municipal rapid-transit,—was no less a revelation to the electrical engineer than to the general public, while the fleet of electric launches on the lagoons scored a success in behalf of the much discredited storage-battery, which was a good second to that achieved by the Intramural. Then there was the unique, but, as the event has demonstrated, thoroughly practicable system of transportation, best known as the "movable sidewalk," which certainly appeals to the mind of the progressive electrical engineer as an idea which is not unlikely to have an important bearing upon the problem which every year presses more and more for a solution—that of furnishing adequate means of conveyance from place to place of the enormous crowds of passengers who throng the sidewalks of our great cities, a congestion which rapidly increases from year to year, necessarily keeping pace with the multiplication of ten- and fifteen-story buildings, each containing a population equal to that of a moderate-sized country town.

OF course that abstract entity known as "the general public," having settled itself into the comfortable belief that there is nothing whatsoever, however difficult or impossible of accomplishment it may appear, which cannot readily be brought to pass by the aid of electricity, could scarcely be expected to grasp the significance of the really significant exhibits, but it was seemingly never tired of gazing with admiration and astonishment at the illuminations, the search-lights, the prismatic fountains, the scenic theater, and other like ingenious electrical diversions, which, although presenting for the most part but little of real novelty or interest to the professional mind, were nevertheless imposing from the mere fact of their number

and profusion, and not infrequently from their completeness from an artistic point of view.

THE seventeen years which elapsed between the Centennial Exhibition of 1876 and the Columbian Exposition of 1893 form but a brief space in the industrial annals of the world, but, brief as it is, it practically covers the whole period of the existence of modern electrical development. A retrospective glance at the Centennial Exhibition reminds one that it was rather remarkable than otherwise for the meagerness of the exhibits illustrative of the progress, or even the then existing condition, of the electrical arts. There was a fairly good display of telegraphic apparatus, and of electric railway-signaling devices. The earliest American dynamo electric machine was on exhibition, and some more or less successful attempts at arc-lighting on a small scale were made, more as a matter of scientific curiosity than anything else. Nevertheless, there were present at the Centennial two exhibits which may fairly be said to have contained the promise and the potency of nearly everything that has served to excite the wonder and admiration of the countless visitors who thronged the vast spaces of the exhibition of 1893.

A GRAMME dynamo which had been imported from France was shown in operation at the Centennial, and the current derived from it was used to drive a motor which operated a small pump, thus furnishing a concrete illustration of the transmission of power by electricity. A certain well-known journal, which is not always quite so scientific in fact as it is in name, made the following comment upon this exhibit, which may be taken, perhaps, to fairly represent the attitude of the average practical man at that date: "As in this double conversion, of power into electricity and electricity into power, less power is obtained than is expended, the machine is apparently of no practical value, but is nevertheless interesting, as showing the relation existing between power and electricity." Only twelve years after the above was printed the writer stood beside a massive multipolar electric motor of 280 horse-power, which was smoothly and noiselessly driving the machinery of an extensive woolen manufactory at Derendingen, Switzerland, receiving its unseen power from a distant Alpine torrent through five copper wires each about the thickness of a common lead-pencil, and it was then and there that he was forcibly reminded of a certain dictum of Hosea Bigelow: "Don't never prophesy unless ye know."

THE other epoch-making exhibit referred to was tucked away in an obscure corner of the educational display of the State of Massachusetts. It consisted of a pair of crudely-made magneto-speaking telephones, by means of which, by dint of vociferous shouting, articulate speech could be transmitted through a wire, in a weak and shadowy way it is true, but still with sufficient volume to enable detached words and even short sentences, to be recognized by a careful and attentive listener. The general opinion of telegraphic experts, or at least of the very small number of them who were sufficiently interested in this new development of their art to hunt up the apparatus and examine it, was "on all fours," so to say, with that which has been above quoted in respect to the utility of electrical power-transmission. It certainly could not have entered into the wildest imaginings of any person present that the time would come, and that within seventeen years, when a business man, without getting out of his office chair in New York, could converse at a minute's notice with any one of more than 100,000 different persons, located almost anywhere between Boston and Milwaukee, and this without raising his voice above the ordinary conversational tone.

IT has been remarked, and not without a good share of truth, that electrical engineering is nine-tenths mechanical engineering. The great fact of the reflex influence of the former upon the latter has been most forcibly exemplified by a study of the mechanics of manufacturing and of

transportation at the Fair. There have probably been more real advances made in the details of the construction of steam-engines, steam-boilers, and water-wheels, during the past seventeen years, than during any other equal period of time in the industrial history of the world. One of the wonders of the Centennial was the double-cylinder Corliss engine rated at 1400 horse-power, which was found to be amply sufficient to carry all the machinery of the exhibition. At the Columbian Exposition, engines of from 1000 to 1500 horse-power were almost too common to excite remark, while a single dynamo, used for supplying power for the Intramural railway, was directly coupled to the shaft of a 2000 horse-power Reynolds Corliss engine, employed for that service alone, and easily capable of yielding 2500 horse-power. The advances which have been made in mere size are of far less importance than those tending to increased economy, efficiency, and accuracy of regulation, especially in high-speed and high-pressure engines. The newer designs of turbine wheels, too, typified more especially by the Hercules and the Pelton, still further serve to exemplify the recent improvements in prime-motors, which have largely been stimulated by the requirements of electrical engineering. The capacity of wheels of given diameter under low heads has been vastly augmented, not only without a loss, but with a decided gain in percentage of useful effect, while the high-pressure impact or hurdy-gurdy wheel of the Pacific slope has been developed into a compact and efficient motor of unique and valuable characteristics. Great advances have also been made in the important matter of the regulation of water-wheels for producing uniform speed under variable loads.

ONE of the most striking features of the Columbian electrical exhibit, viewed as a whole, was the simplicity and elegance which characterized the design of the large generators, motors, and switchboards. It would be difficult to imagine a greater contrast in this respect than that which appears between the angular and unredeemed ugliness of the early Gramme and Farmer-Wallace machines of 1876, which were in evidence in the historical exhibit, and the simple, flowing and graceful outlines of the massive electric-railway generators of the Westinghouse company. A notable advance in this direction has been apparent, during the past two or three years, all along the line, and from present indications it seems not unlikely that the characteristic American designs of heavy electrical machinery will for all future time bear as unmistakable an impress of the personality of George Westinghouse, as the typical American locomotive of to-day does of that of William Mason. The tasteful designs of the miscellaneous electrical apparatus of the Western Electric Company are also notable.

AN observer with a practised mechanical eye could hardly have failed to have been impressed with the fact that the output of mechanical energy, either per square foot of floor space or per cubic foot of space in three dimensions, is always very much greater in the case of the electric dynamo or motor than in that of the steam-engine, and this is still more strikingly apparent if the boiler is also taken into account. Wherever a huge engine was coupled directly to the shaft of a dynamo, the fact that the steam-engine was two or three times as bulky and heavy as the dynamo could hardly escape notice. The remarkable compactness and simplicity of the electric motor is a feature which must ultimately tell heavily in its favor, when the art of distributing power from central-stations in large and busy cities, in which space is costly and valuable, becomes more general than it is at present.

THE great vertical compound-condensing Reynolds-Corliss engine which formed the principal feature of the power-house of the Intramural railway at the Fair, made a most magnificent record. It was never once stopped during the period of the exhibition for repairs to the engine proper, and yet it propelled no less than thirteen trains of five heavily-loaded cars each, through the working hours of each day. The award committee watched the work

ing of this engine on one occasion for twenty-three hours in succession, and satisfied themselves that while running at 100 revolutions per minute, its speed did not vary as much as 1 per cent., even when the gross load was suddenly reduced something like 50 per cent. A few years ago the construction of such an engine would have been scouted as an utter impossibility.

A PROMINENT civil engineer, in a recent communication to a technical journal, draws some interesting comparisons between the service of the Intramural railway of the Columbian Exposition and the Chicago Southside elevated system, operated by steam locomotives. He points out that for a given passenger capacity, the aggregate weight of the steam train is approximately double that of the electric train. The style of cars now in use, and the economy of putting as many cars in each train as can be started by the locomotive, induces the running of heavy trains at comparatively infrequent intervals, both for suburban and municipal traffic. The result is, that wherever the electric trolley-car, with its one-minute intervals and no-time schedule, competes with a steam line with trains fifteen or twenty minutes apart, it naturally takes the lion's share of the business. The opinion is expressed that the best practice in electric transportation will be found to be separate locomotives for long and infrequent trains, and electric motors attached to the trucks of passenger cars for light trains making frequent stoppages.

THE *Electrical Review* (London) expresses the opinion, in which most unprejudiced engineers will, we think, heartily coincide, that electrical engineering progress on both sides of the Atlantic is lamentably hindered by the senseless employment of so many different rates of frequency in alternating installations. No less than four different rates are in use in London, it seems, and the number in the United States is certainly greater rather than less. The *Review* believes that the losses at the higher frequencies must compel the electric companies to lower them at least one half, and that at no distant date. Indications are not wanting that the standard frequency in this country will ultimately be fixed, either by common consent or by the exigencies of commercial competition, at 7200 or less.

A WELL-KNOWN electrical engineer, as a contribution to the discussion which occasionally crops out in the technical journals in reference to the comparative cost of producing electricity by steam and by water-power, cites one instance of a water-power plant, the total cost of which, in round numbers, was $150,000, and which completely paid for itself within two years from the time it started. In the case of another plant, the cost of which was about $30,000, the working capacity was increased several fold, without any addition to the previous cost of operation. Every such plant, however, requires the most careful and intelligent preliminary study, before deciding upon the capacity and type of the machinery to be used. In figuring upon a plant of this kind, it must not be forgotten that the character and amount of the source of power is fixed by nature, while the amount of electrical energy which can be profitably utilized is also arbitrarily confined within certain narrow limits, so that the whole design must necessarily be a compromise between conflicting, if not absolutely antagonistic, conditions, a situation which challenges the skill and knowledge of the consulting engineer in an unusual degree.

THE first experimental trial in this country of electrical canal-boat propulsion has been made on the Erie canal at Brighton, a few miles east of Rochester, N. Y. The performance went off with great eclat, and was attended by a large concourse of distinguished personages, including the governor of the State. According to the enthusiastic reports furnished to the newspapers, the experiment was one of the most remarkable successes of the present age. A careful study of the conditions under which the trial was made lends color to the suspicion that this particular demonstration was exploited rather for advertising purposes than as

the inception of a bona fide business undertaking. No electrical engineer, so far as we are aware, ever entertained any doubt that an electric motor is capable of propelling a canal-boat as rapidly, as economically, and with as little disturbance of the water as a steam-engine, if not more so. The whole problem, from a technical point of view, appears to consist in getting the current from the trolley-wire to the boat, and on this vital point the results of the "official" trial shed no light whatsoever. The devices used appear from the descriptions to have a makeshift adaptation of ordinary overhead street-railway apparatus, and were of a type which will, we venture to predict, be found wholly unsuitable for actual canal service. While no doubt need be entertained of the ultimate success of the scheme, it is difficult to understand why the working details might not have been elaborated at least to a sufficient extent to afford a real demonstration of the prospective merits of the system, before bringing it before the public with so great a flourish of trumpets.

THE winding and setting of a good-sized tower clock of the time-honored pattern is by no means a small job, inasmuch as the raising of a ton or so of dead weight to the top of a high tower once a week, is necessarily a work of time as well as of labor. All this drudgery, it appears, is henceforth to be performed by the ubiquitous electric motor. A new clock recently placed in the building of the Waterbury Clock Company, in the thriving Connecticut city of the same name, is not more than one-fourth the weight of a tower clock of the ordinary type having dials of equal diameter, and the whole machinery is operated by electric motors supplied with current from a sal-ammoniac battery of ten cells, which will run for a year or two without renewal. The great saving in actual power required to propel the clock largely results from the fact that the electric force is applied directly to the point where needed, without the intervention of the complex mechanism essential in weight-clocks of the ordinary type.

IN the construction of overhead lines for the conveyance of currents of high potential for electric lighting and power service, the greater part of the experience which has been gained during the past fifty years in the construction of telegraphic lines has apparently been altogether ignored. The ultimate results of this policy will be found to be eminently unsatisfactory. The early builders of electric-light lines simply copied in an unintelligent way the existing construction of the principal telegraph companies, using the same rickety ill-fastened cross-arms, weak wooden pins, and cheap glass insulators, that had been found barely tolerable for the low tension currents and light wires of the telegraphic service, for the heavy copper rods and high tension currents of the arc-lighting service. The mechanical features of this construction have been improved by the electric-railway constructors, whose more recent lines are doubtless sufficiently strong, although the conditions of insulation still leave much to be desired. As for the power lines, the glass insulator has been enlarged and strengthened, and so has its wooden pin, and in some few cases an inner cup for insulating oil has been added to the former. The only really serviceable and trustworthy insulator for a line for electric light and power service is the genuine vitrified porcelain used in the telegraphic service of Continental Europe, mounted on a strong wrought iron pin or bracket, and preferably supplied with an internal oil cup. The miserable clay imitations of domestic manufacture, which are sold under the name of porcelain insulators would for the most part not be worth putting up even if they were given away. There ought to be a thorough reform instituted in this country in the way of electric line construction. This department seems to be a favorite field for the operations of the particular class of economists who save at the spigot while wasting at the bung-hole.

ARCHITECTURE

Conducted by Barr Ferree.

ARCHITECTURE is the only art, profession, business, trade, occupation, industry in the world in which a man who knows nothing about it, who has failed in it, who has no ideas about it, can succeed. We trust there will be no undue rush to enter a profession in which the greatest prize can be obtained with the limited intellectual equipment indicated in these words. Neither would we imply that architects are not thinking people, or that hard-working, wise architects do not achieve success. Our opening statement, in fact, needs only to be made, to have its truth at once recognized. Why is any one a successful architect? Because he designs well, knows how to make a plan, has a keen artistic insight and sensibility, is a good draftsman, is entirely up in all the questions and problems presented by his profession? Not at all. An architect is successful if he commands a good practice, and he can command a good practice only by his personal connections, the friends he has, the confidence with which he can inspire his friends and acquaintances. This is the reason of success in architecture as it is now practised. There is no secret in it. We almost feel that an apology is necessary for introducing here anything so well known; but it is good, sometimes, to review thoroughly familiar facts. An unsuccessful lawyer cannot "succeed," no more can a poor doctor. No one, however close the connection, will give an important legal case to a lawyer for whom he has no respect, whose knowledge of law he feels to be inaccurate, and whom he knows will be an impediment instead of a tower of strength. Neither will one call in a physician to perform a delicate operation, or even for an ordinary case, simply because he knows him to be a good fellow. The poor lawyer, the poor doctor, the poor business man must all go to the wall if they cannot give evidence of ability to perform their respective tasks. It is not so with the architect. He may buy artistic skill, employ the most expensive and wisest engineers, and the most ready draftsmen. There is no limit to the special intelligence he may have and make his own if he wishes to obtain it. His own part need consist in nothing but his ability to hustle and get "jobs," and with this he may be well content. Knowledge of architecture, experience, artistic feeling, the architectural spirit, ability to design, all these, fundamental and elementary as they may seem, need have nothing to do with his success.

PEOPLE do not go to an architect because they think his work is good, or because they realize the power of his genius, as they realize the power of a painter or a sculptor, perhaps. As a rule people themselves know nothing about architecture, and so many bad things are done nowadays that the public taste is fairly educated on bad things. A very high building passes, popularly, as very high art, and the highest building of all, as likely as not, as the finest thing in the world. If an architect has had many jobs, and especially large jobs,—if his name readily occurs to one as an architect when one thinks of building,—he is forthwith commissioned to design a building which the projector and owner may be quite incapable of appreciating. Eminence did it you know, and apparently there is a power in Eminence's name. In this case professional activity brings the architect business, but it is only professional activity; professional ability, which is the measure of success in every other calling under the sun, has absolutely nothing whatever to do with it. All this is un-

pleasant, but is it not true? These discouraging conditions exist all along the line. They influence the architect's entire career. They discourage excellence of work, since it is not excellence that brings success, but activity. It is the crowded office, the immense drafting-room, the busy partners, the fuss, the drive, the turmoil that mark the busy architect. In many instances, the work is so divided up, so differentiated and distributed, that one man does the plan while another makes a façade that ultimately is to fit the other fellow's plan. An architect, moreover, can get rich only by increasing his practice. Unlike the painter or the sculptor, with whom, indeed, he has no relation or connection, he does not put up the price of his wares with increasing fame. Even the poor literary worker may do this; the successful maker of mint-juleps and of cocktails, the manufacturer of trousers, the scavenger, may each and all put up their prices, but the architect remains at one level, deals out good and bad at the same price, the product of his mature mind and of his student portfolios perhaps. All are treated alike, and thus it happens that architecture is a profession,—or an art, if you will, in which a man who knows nothing about it, who may not be fitted for it, who may not even like it, may achieve a lasting and gigantic success.

ARCHITECTURE is the art of solving practical problems, many of which have no connection, artistically or otherwise, with building, but all of which influence the artistic form of the structure, and all of which must be considered in any rational design. All design, and especially all modern design, is far from being rational. One need but to look through the streets with which he is familiar to meet the most amazing designs, the most astonishing contortions of the building art, the most surprising combinations of things well enough in themselves, but utterly absurd in unexpected and unappropriate places. It is unfortunate and unpleasant that such things should be, for a building—especially a large and costly one—is not a thing to be taken down because its art is bad. But a study of these unfortunate works of architecture is useful in pointing the meaning of the definition with which we have begun. The most conspicuous fault of current work is its ignoring of the rational An architect is a thinking man, and with an artistic architect a building is a product of his thought. It must, therefore, be rational. Yet in multitudes of instances it is not. This need not be demonstrated, because the examples of it are so numerous and so evident. Nor need the question be argued and a decision obtained from theoretical principles only. Of all the artistic things men do architecture most depends upon rationality as a basis. And this is simply an expression of the conditions and limitations under which it has developed. It is true that in the golden days of the historic styles architecture was concerned only with the solution of a few problems of comparative simplicity. In the present day we have no historic style to work in,—we can, unfortunately, take any style, and even maltreat that if we will,—and we have a multitude of problems. Yet this multiplicity, this complexity, this diversity is itself a fresh source, if it were needed, of rationality. The more complicated the problems, the more diffuse and difficult the conditions, the greater the need for rational treatment, the more the architect must think, the more refined and intellectual must his work become. But Greek architecture was wholly intellectual and wholly artistic. These two qualities are properly strongly united by the closest of ties.

THE New Zealander, if he ever stands upon the ruins of London bridge, will see no more amazing sights, will find no more profitable food to ponder over and write up on his return to his antipodal home, than every New Yorker may now see and ponder over in the structures surrounding the City Hall park. A large open space in a crowded city is naturally a favorite building site. Nowhere else do the buildings show to better advantage, nowhere else are there greater opportunities for the exercise of architectural talent, nowhere else are failures more conspicuous. This latter

fact, indeed, does not make an open place more desirable for building, but it is one of the misfortunes the general public must suffer from when once the architectural innovator gets a foothold. The streets surrounding New York's City Hall park have long since been favorite ones for important buildings. The newspapers—those shining lines of civilization and of culture—have long since preëmpted Park row. The Post-office cuts off one end; the opposite side, Chambers street, is somewhat hidden by the Court House. Broadway alone, until the present year, has suffered no great change. But already this belongs to the past. The innovator has arrived, and with him a series of buildings, not one of which has any artistic reason for existing. What a spectacle greets the bootblack as, seated on the reverse side of his place of business, he awaits the morning customer at the Murray-street entrance. Across Park row is the marvelous dome of the Pulitzer building, that greatest of all architectural pyschological curiosities, with further off the *Tribune* and its tower, which the bootblack surely does not suspect to have been made by an architect of eminence. Further along is the *Times*, the best of the lot, perhaps, and certainly affording an agreeable contrast to the Potter "pile." Then, if our small Italian will turn his place of business and himself around and look up Broadway, he will see the just-finished Mutual Reserve building, further down the extraordinary chimney-with-a-hat-on-it front of the Shoe and Leather Bank. Then the new white marble front of the Home Insurance Company, striving to go up, though held down by many horizontal lines, and next to it the structure with an impossible arch, and various other idiosyncracies recently put up by the Postal Telegraph company. Shall we ask our Italian what he thinks of these? Perhaps he does not think, revolving there upon his place of business. There are such people, there must be, else how could these things be?

"WHAT Order do you call the first story?" said the friend to the architect who was showing him his recently completed building.

"That's the Doric!" replied the architect.

"And what do you call the second story?"

"That's the Ionic!"

"And the third?"

"That's the Corinthian!"

"And now tell me what's the thing up on the top?" anxiously inquired the friend.

"Oh," said the architect, "that's the Order of the committee!"

This ancient yarn is introduced into a collection of articles on the architecture of the Fair by Philadelphia architects, published not long since in one of the Philadelphia daily papers, and is contributed by Mr. Frank Furness. The articles are accompanied by a series of photographs of the contributing gentlemen representing the most woe-begone people we have met with for some time. We do not know why one's written remarks are more to the point when embellished with an accompanying photograph, but it is not often that the results are so disastrous as in the present instance. Mr. Furness's remarks express a great truth and a great fallacy. The ignorance of the general public, and even of that part of it which, for business or other reasons, is concerned directly with architecture, is truly amazing. The most extraordinary things are being erected by people who know nothing about architecture, but who imagine that the more amazing the structures they build the better art they are getting for their money and the better they are furthering the interests of architecture. Incidentally it may be remarked that, were it not for this circumstance, many architects would be unable to make a living in their profession. Of course Mr. Furness has no notion of teaching such a lesson as that, but in condemning the public it is well to keep in mind that the architects who do extraordinary things are only able to do them with ignorant clients, who encourage them in their making of monstrosities and help along the worst interests of the profession as best they may. This is the great truth Mr. Furness's anecdote teaches, unpleasant as it may be in its entirety to the architect.

THE fallacy is implied. There is no reason why architectural knowledge should be limited to the architects. Grant, if you will, they are the leaders in architectural movements; leadership does not imply exclusive and copyrighted rights of knowledge. The contempt with which architects sometimes look upon the public is most unkind and unnecessary, and does a great deal in nourishing the contempt which is becoming chronic with these two great classes, which could help each other so much if they would. The truth is that architects, as a class, do not appreciate the duties they owe the public as professional men. Immediate advantages and quick personal returns are more likely to influence the architect in deciding a course of action than broad questions of policy that might bring no returns for years to come. The generally inchoate condition of architectural societies, of which the American Institute is itself a notable instance, is quite sufficient proof of this state of affairs. The architect, existing as he does solely at the convenience of the public, being a wholly useless member of society alone and by himself, apart from the public, depending upon the public for opportunities to exercise his talent, to display his ideas, to make manifest his incompetence, if he be incompetent, owes the public a debt of professional knowledge he has not yet begun to pay. If the public knows nothing of architecture, save what it gains from the inspection of contemporary monuments, the architects have only themselves to thank for it if it insists, once in a while, on an Order of its own being placed on top of the classic Orders. It knows no better, poor thing; how could it think this proceeding wrong, especially when, as likely as not, the adjoining structure has an architect's Order of amazing style and form? Men in all branches of trade are constantly spending money that actually goes to the general betterment of their industry, knowing full well that in the end it will be repaid to them many-fold. One of the shrewdest advertisements ever inflicted upon a long-suffering public was the simple name of the manufacturer of the goods, without a hint of what he was advertising or how it was to be used. Naturally curiosity was excited, and when the product was finally announced it had a widespread celebrity it could have had by no other means. Architects cannot do just this thing, but they can help the diffusion of the true principles of their art among the public in a useful and beneficent manner if they will but set about doing it. The architects are really to blame for the architectural idiosyncracies they so much deplore.

HAVE you seen the Columbus Memorial building in Chicago? While it is not, in itself, worth a journey of a thousand miles, it is the most amazing product of the Columbian year in the City of the Fair. Located at the junction of two principal thoroughfares, it has the unfortunate advantage of being seen by all men, though such is the state of architectural appreciation that it may not be judged by all as it should be. It occupies a large and generous site, and the architect was not hampered, apparently, in this respect by the exacting conditions that spoil many a commercial building before it is erected. It begins with a basement or base in two stories that, appropriately enough, are given up to stores. It starts out therefore with the appearance of a brick building elevated on a glass base. The building proper really begins with the third floor. But the makers thereof were timid men: they could not build higher than a single floor before they must needs put in a string course, for no other apparent reason than to suggest that it was necessary to pause here for further thought. Emboldened by the success that attended their efforts thus far, they piled up two additional stories, sufficiently unobjectionable in themselves, only to stop again with a cornice of considerable width. Here, it may be presumed, the basement of the building came to an end, for otherwise there was no reason for running the cornice around the structure, though truly a three-story brick basement on a two-story glass sub-basement is a combination the like of which is not frequently met with even in this day of strange doings. Then comes a great spurt of ideas: five stories

without a horizontal line, the windows being enclosed by pieces of walls—they are not true piers—ending in flat arches. At this point it was apparently judged necessary to begin to get to the end, and accordingly a single story of new design is built with a string course below and a cornice above. But this was not high enough and another single story was built, crowned by a wide cornice which marks the conclusion of the lower portion of the building. A simple cornice would never do for so complex a structure, and another single story is built over this, and over it, again, in the center of the two fronts, a two-story gable, ending in a circular pediment. Meanwhile it should be pointed out that immediately over the glass basement the building breaks out on the corners into bow-windows which are continued to the top. These are not put on bow-windows, mark you, but integral parts of the wall, so that the whole building exhibits a rich picturesqueness of outline that has seldom been surpassed, but which is surpassed in this very edifice by an octagonal tower on the corner ending in a dinner-bell dome that finely assists in breaking up the sky-line. This latter end is further helped by copper eagles and other ornaments on the gables that add very much to the spread-eagleism of the structure, as they were doubtless intended to do. Finally the general variety is concluded by the use of copper cornices, making the whole one of the most marvelous combinations of glass and brick and copper now visible on the face of the earth. It is a wonderful building done in a wonderful manner, and one which words alone quite fail in describing. Fortunately Chicago has other memorials of the Fair than this, but it is a pity the memory of its greatest success should be associated in any manner with this piece of architecture.

IT is a somewhat significant fact that, while the architecture of the World's Columbian Exposition was admitted on all hands to be its most distinguishing features, the magazines and papers which are now printing backward glances at it, summary reviews and criticisms of all sorts, kinds, and conditions, have not included a single architectural writer among their contributors. Literary men without number have expatiated on the splendor of the architecture, have told us how great it was and how they were impressed by it, but not one of these people has any architectural standing. Most of them, in fact, know absolutely nothing about architecture, but imagine that, because certain structures seem to them good, they are quite competent to instruct others who know less than they do about them. A more flagrant case of the blind leading the blind it would be difficult to find. Of course it is impossible to stop people from writing on architecture if they think it their vocation to do so, and there would be no great harm done if their opinions were properly discounted. But the views of a literary man of wide reputation on any subject are apt to have an enormous vogue among the rabble simply because the name attached to them is familiar. There has been a vast deal of undignified writing about the Exposition and its buildings, and most of it has come from people whose knowledge of architecture is nothing at all. This procedure has done more than anything else to discount the real value of the Fair abroad. But in the end it has been a more serious reflection upon architects than any special loss to the world at large. Architects are apt to be biased folk and are fond of looking at their art through their own special stylistic spectacles. This in itself is so perfectly natural that it is difficult to find fault with it. Meanwhile every man and woman who can get into print is engaged in telling the world that the architecture of the Fair was its strongest point, congratulating the American people that they produced it, congratulating themselves that they saw it, congratulating the public that it is able to read their views.

Conducted by Thomas L. Greene.

IN considering the question of the proper charge of certain classes of improvements,—whether to operating expenses or to capital account,—it was stated a month ago that a railway was valuable only for the purposes of transportation. It differs in this respect from a parcel of ordinary real estate. A house, if sold under foreclosure, may be bought by some one in a line of trade different from that of the mortgagor. The mortgagee thus really relies upon the whole community for the safety of his loan. But a railway plant costing, say, $50,000 per mile, is worth but a small fraction of that cost except as a roadway for trains. Hence the reliance of the owner of a railway bond is in reality not upon the real estate, considered as such, but upon the earning power of the company as a carrier of traffic for hire. In discussing receiverships we have already seen that a mortgage upon a railway cannot be foreclosed and the assets divided, because public policy demands that a railway shall be kept running. The same conclusion is arrived at also as a matter of finance, because bondholders would get very little indeed if the right of way were to be sold as land to the adjoining farmers.

THE practical result of all this is that the strong language in which railway mortgages are drawn does not mean all it says, and that the holder of bonds is in great measure dependent for his money on the success of the railway in its business as a common carrier. From this conflict between legalities and facts arose our American system of receiverships and reorganizations, which keep up the fiction of an absolute lien while practically allowing a readjustment of capitalization to correspond with the real earning power. Our large systems are usually made up of a number of smaller lines originally independent and having their own bonds. Then we have bonds on terminal properties, bonds on divisions, and, last of all, "blanket" bonds, covering everything, but subject to the prior liens. When such a system finds itself over-capitalized and compelled to ask for readjustment, the task is complicated. The first thing to ascertain is the minimum of net earnings in a bad year. The fixed charges must then be cut down to this sum. Prior bonds on valuable portions of the road cannot be disturbed, so the losses usually fall on the division and blanket mortgages, with perhaps an assessment on the stock with the alternative of forfeiture. These losses must be adjusted by competent hands in proportion to the real value of the respective mortgaged properties to the system as a whole. The majority of the bondholders usually accept the plan if fair, the wording of their mortgages to the contrary notwithstanding; the minority by a transfer of title to a new company may find their opposition futile.

But American railways are judged not merely by their present earning power, but by the possibilities of the future. It is generally considered inequitable in a reorganization to cut down the principal and interest of bonds because of present depression, without giving the losers some evidence of their claim upon a possible increase of earnings. This evidence may be in the form of income bonds,—with interest payable only if earned,—or of preferred stock. In either case the security would represent deferred claims upon the company. For a number of years income bonds were favorites. The old idea of the sacredness of a "bond" still lingered and financial houses profited by the feeling. Nevertheless an income bond should have

no place in carefully-considered plans. It is a contradiction in terms to speak of a bond on which payments are contingent. There can be, broadly speaking, but two classes interested in a railway or other company—creditors and partners. A bond whose obligations must be met under certain penalties makes its holder a creditor of the company. That creditor has loaned his money at a fixed rate of interest, with the plant itself as security. The fluctuations in the profits do not concern him unless his security becomes imperilled. On the other hand, stockholders are not creditors of the company, but partners in the enterprise. If the profits are large, they get them: if no profits at all appear, they suffer, but without redress upon the property. When, therefore, a bondholder for any reason accepts an income bond for part of his claim, he really changes his position. He is now dependent upon the fluctuating success of the company and in so far is a partner in the business. It confuses the real status in the mind to still call his deferred claim a "bond."

THE Atchison reorganization was highly successful. Holders of old bonds exchanged them for new general bonds and income bonds. In a few years the defect of the reorganization—unnoticed at the time—appeared. No provision had been made for fresh capital, while no road—particularly at the west—could stand still without improvements. When, however, the management began to consider the question of raising this new money, the income bonds stood right in the way. If the deferred claims had been turned into stock, the difficulty would not have occurred. As it was, no new bond could be in terms put ahead of the incomes. The only alternative therefore was the creation of a new mortgage into which the income bonds could be converted on terms favorable to them, and which should also arrange for other bonds which could be sold to the public. Thus, by the oversight of the reorganizers in a plan otherwise of the highest order and which proved a model for other companies, new bonds had to be put upon the property bearing fixed obligations under penalties of foreclosure, whereas the original intention was that only the general bonds should be an absolute yearly charge while all other payments should be optional and conditioned upon the varying prosperity. Experience, as well as true theories of finance, demands that contingent claims upon future profits should be represented by preferred stock, and not by income or preference "bonds."

IT is in this way that most of the American preferred stocks have arisen. They represent in most cases a cutting down of some old obligation and are therefore entitled to consideration. This consideration they usually get, for most of them are to receive good dividends before the common shares obtain any return. From this circumstance of conceded priority there has grown up a sentiment that preferred shares are in effect bonds, thus applying to them something of the claim which we have discussed regarding income or preference bonds. It would be needless to say that these extravagant claims regarding preferred stocks should have no weight, were it not that at times efforts are made to insist upon them. The St. Louis and San Francisco first preferred stockholders were entitled to 7 per cent. per annum, and when dividends were withheld tried to enforce their demand in a suit. As we have before remarked, all shareholders are partners, and one class, even though granted priority, could not force from the other class or from the business what had not been earned. So far was this claim for priority carried that in some instances mortgages were given to secure the preferred stock's dividends. The St. Louis, Alton and Terre Haute has issued a dividend mortgage for this purpose. A case came up in an Ohio court which involved the validity of a mortgage given to preferred shareholders, the court deciding against the bonds.

A QUESTION of ethics in finance of greater difficulty is raised when we consider the cases wherein preferred stocks are to receive high dividends in perpetuity. A railway running out of Chicago two de-

cades ago made the dividends on its preferred shares the same as the interest on its bonds then outstanding—7 per cent., which was the usual rate of interest on money at the time. The bonds had also the unusual feature that at any time they could be converted into preferred stock. Several millions of dollars of maturing bonds have already been exchanged and about $24,000,000 of additional bonds, maturing within ten years, doubtless will be so converted into preferred shares. Practically this arrangement continues to those maturing bonds a perpetual interest or dividend payment of 7 per cent., before the common shares receive anything. The rate of interest on first-class security has fallen from 7 to less than 5 per cent. The company could undoubtedly renew the expiring bonds at 5 per cent. or under, so that a large saving—amounting to nearly 2 per cent. on the common stock—could have been had, if none of the old bonds had been convertible. Concurrently with the fall in the rate of interest, the net earnings of all railways have greatly decreased in proportion to the volume of traffic, while capitalization is increasing. The advantages given to these preferred shareholders twenty years ago was equitable, but now it bears inequitably upon the common stock. The theory of the preference undoubtedly is that the favored shares shall have the first claim to an average return. There is no evidence that a payment much beyond the common interest on money was ever intended. This brings up what we have just called a question of much difficulty in the ethics and practice of corporation finance; namely, whether it is right ever to change a contract which compels continued payments indefinitely, when the circumstances under which the contract was first made have been materially modified. No machinery at present exists for solving this problem.

THE perennial puzzles of the railway-rate question are again exemplified in a case decided by the United States Court for the Virginia circuit. The Delaware Grange complained of the New York, Philadelphia and Norfolk (a part of the Pennsylvania system) because of its charges on farm truck from that peninsula to Philadelphia. The commission decided against the road, which declined to obey the order. The court dismissed the case when the commission tried to enforce its decree. The Norfolk road showed by comparison that its rates on truck were lower than those charged by lines on the main land, that these rates left the company at the end of the year without profit, and that they were really fixed by water competition and therefore must be reasonable. "Favored by nature and doubly favored by these lower railroad charges," says the court, "if the citizens of this peninsula are still unable to secure a profit upon the sale of their vegetables, the misfortune cannot in truth or reason be ascribed to the freight tariffs of the defendant company." The case is a good example of the position taken by certain classes of our citizens who clamor for lower railway charges regardless of consequences. Even a railway cannot overturn all the laws of trade, or continue long to carry stuff below cost or without a reasonable profit, even to please the Delaware farmers.

THE receivership of the Union Pacific may lead to great complications. The second mortgage bonds of the road guaranteed by the federal government fall due from 1895 to 1898. Figured to maturity and adding the interest in arrears, the total is not far from $60,000,000. The first mortage also falls due at the same time, aggregating $30,000,000 more, while the Collateral Trust notes, about $12,000,000 and covering all the bonds and stocks of branch and auxiliary roads in the treasury, mature in 1894. The total indebtedness of the system is about $250,000,000. The system is composed of two main lines from Omaha to Odgen, Utah, and from Kansas City to Denver, together with a large number of subsidiary roads which vary greatly in their earning capacity and intrinsic worth, but which furnish to the main lines a large part of their traffic. Without these auxiliary lines (con-

trolled by the Collateral Notes and by the branch bonds in the hands of the public) the main lines could not earn interest on anything but the first mortgage, leaving the government lien all but worthless. On the other hand, the subsidiary roads have no outlet except over the main lines. If the government should compromise by exchanging its present mortgage for a long time loan at low interest, the company, when normal times returned, would arrange its finances and go on. Without such a compromise the situation presages conflict and loss. The proposition of Nebraska people that the government shall discharge the debt so that their rates may be reduced, is ingenious but hardly defensible. Nothing is certain as to the outcome until the federal policy is disclosed through Congressional action though a committee is now trying to arrange a plan of reorganization to be submitted to Congress and the private bondholders, which it is hoped will be acceptable to all interests.

So many important companies are now in the hands of receivers that questions concerning their power and duties are timely. One of these questions relates to contracts. When a receiver is appointed for a corporation, he must operate the property as an officer of the court and strictly in accordance with the policy which at the moment seems best for it. Hence it is quite common to find receivers cancelling contracts made by the old corporation which are no longer profitable. Such for example are the payments of guaranteed interest on branch-line bonds which now cover roads of little or no value to the company. If the fact of direct loss be clearly shown to the court, the judge will order the lease discontinued and the payment stopped. In such cases it is supposed by many that the action of the court is final and that the liability of the corporation is at an end. This supposition is incorrect. A court having possession of the property of a corporation must run it so as to yield the most revenue at the moment, nor can any bondholder or other claimant dispute such action. Yet the force of the original contract survives, awaiting its opportunity.

If a compromise is made with other creditors, so that the original company is able to take back its property, then each of these old and uncompromised contracts revives as to its original claim and also as to all accumulations and arrears of interest during the receivership. All are liens on the property. It is because of this fact that reorganizations are usually accompanied by the formation of a new corporation to which the property and franchises of the old company are conveyed at foreclosure. By foreclosure those other claims are extinguished. But without foreclosure proceedings they are still claims against the old corporation.

THE matter is complicated when for any reason it is desirable to retain the old charter. A wiping-out of old debts would then be no object compared with the loss sustained by the relinquishment of the old rights. In the case of the Texas and Pacific an arrangement was reached by which a new capitalization was effected based on the old; thus a valuable federal charter was retained. But where no compromise is possible, because many varied and conflicting interests are unable to reach any agreement, it sometimes happens that receivers remain in possession for a long time until the different creditors are wearied into accepting some plan of readjustment. The point now to be considered, however, is the fact, not generally understood, that a company whose rentals and guarantees are a source of danger to its solvency can throw off those burdens only by a sale of its property and franchises to another corporation. Any rehabilitation which preserves its charter or the existing stockholders' rights, must deal also with these rentals and guarantees. If valid otherwise, there will still be a claim upon the property after the receivership is discontinued.

CIVIL ENGINEERING.

Conducted by John C. Trautwine, Jr.

A GREAT object-lesson, in civil as well as in other engineering, and indeed in every conceivable object of study, has closed. The students have gone to their homes, and the professors are following their example. The schoolhouse, vast and beautiful and instructive beyond description, begins, alas, to present the air of a banquet-hall deserted, and must soon resolve itself into the chaos from which it sprang.

> The cloud-capped towers, the gorgeous palaces,
> The solemn temples, ...
> .....shall dissolve;
> And, like this unsubstantial pageant faded,
> Leave not a rack behind.

The World's greatest and grandest Fair is at an end, but the lessons it has taught will live on in the minds of men. Perhaps no other space of equal area within the exhibition was so full of matters of interest to the civil engineer (using the term now in its narrower sense) as was the southern end of the gallery of the Transportation building, devoted to the exhibition of the engineering interests of Germany. Professor Reuleaux—whose monumental work, "Der Konstrukteur," has just been laid before the English-reading public by Suplee's masterly translation—Professor Reuleaux, upon his return to Germany after the Centennial Exhibition of 1876, added a small but important stone to the already well-established structure of his immortality, and at the same time incurred the widespread disfavor of his compatriots, by characterizing the German exhibits at Philadelphia as "billig und schlecht" (cheap and nasty). The seed seemed to have fallen among thorns, but it has borne magnificent fruit in the character of the German exhibits, and notably of the German engineering exhibits, at Chicago, which were as far as possible removed from anything like cheapness.

One of the most prominent of the exhibits in the German gallery of the Transportation building consisted of the models representing the North sea and Baltic (Nord-Ostsee) ship-canal. This great work extends from Brunsbuettelhafen, on the right bank of the Elbe near its mouth, via Rendsburg, through the historic Schleswig-Holstein to the mouth of the Eider, near Kiel, on the Baltic, where the canal commission has its seat. It is sixty-one miles long. Its bottom and top widths are 72 and 213 feet respectively, and its mean depth 30 feet. It was begun in 1886, and it is expected that it will be completed by the end of 1894. The cost is estimated at $39,000,000, and, judging from present indications, it is believed that this figure will not be exceeded. Its prime object is of course to avoid the tedious and perilous voyage around the Danish peninsula and through the Skagerrack, but the German government of course is not blind to the advantage of access through German territory to the North sea. The writer had the good fortune to listen to a description of this model from the lips of Herr Theodor G. Hoech, technical attaché to the Imperial German legation, and was not a little interested at the recital of some of the considerations that were kept in view in designing the work. To American ears, for instance, it sounds curiously to hear that the engineers had proposed thus and so, but that "the emperor" wished it otherwise, and that the plans were "therefore" modified accordingly. We realize, too, something of the price the continental nations must be paying for what they dignify with the name of patriotism, when we are told that all bridges and locks had to be built in duplicate, to provide against possible crippling in time of war. There will be tidal locks (double, of course) at each end, but otherwise the canal will be free from locks. Six passing places, each 1476

feet long, 197 feet wide, and 7½ miles apart, have been provided in order to allow two large ships of war to pass, and numerous opportunities for passing are afforded also by the lakes along the course of the Eider, through which the line of the canal passes.

A fine model, 26 feet long and 10 feet wide, showed the arrangement of the locks at Holtenau, at the Baltic end of the canal, and the necessity for duplicate lock-chambers was utilized in the model by constructing the northern chamber of metal, so that it could be filled with water, and the southern of wood and in such a way that portions might be withdrawn so as to expose the internal construction. Even the hydraulic motors were faithfully reproduced in the model, but, owing to the smallness of the motors in the model, it was not convenient to operate them by water power and they were accordingly worked by hand, as indeed their larger prototypes could also be operated in case of their failure to work hydraulically as intended.

SCARCELY less interesting, although illustrating a piece of work geographically more remote, was the exhibit of G. Luther, engineer, of Brunswick, Germany, containing models and drawings illustrative of the gigantic task of regulating that "highly international" stream, the Danube, in its forty-eight miles of rapids, culminating, at the point where Hungary, Servia and Roumania meet, in the far-famed Iron Gate. This work is being carried on by means of coffer dams, which are pumped out by turbines operated by water-power derived from the river itself, and the rocky obstructions to the channel are thus attacked and removed in the dry. The completion of this work, together with that of the Danube-Oder ship-canal, will give a continuous water-way, "straight across Europe," from the Caspian sea to the Baltic and North seas.

VISITORS who had wandered southward through the colossal locomotive exhibits of the Transportation building and its annex, and who came out upon the unique display of the "Georgs-Marien-Bergwerks und Hütten-Verein" at the southern end of the annex, were apt to suppose at first sight that here a portion of the building had been left unoccupied, or at least that the exhibits intended for it had not yet been installed. No greater mistake could have been made; for this space, devoted to a most remarkable collection of specimens of railway track from all countries, and from all times during which railway track has existed, was remarkable as well for its completeness, its accessibility, and the extent of information furnished, as for its great extent. But although in length and breadth this was one of the most extensive exhibits in the Transportation building, in height it was, by reason of its nature, singularly inconspicuous, and hence must have arisen the impression referred to.

Beginning with a bit of an ancient wooden road of Roman construction, dug up in the neighborhood of Osnabrück, where this much-titled corporation has its establishment, this exhibit contains no less than sixty-eight full-sized specimens of track and track-fastenings, or what our British brethren call "permanent-way." The collection was arranged with very close adherence to chronological order. Immediately following the Roman road referred to, was a piece of wooden railway used in mines in the remote parts of Hungary from the sixteenth century to the present day, the rails composed of round logs, which were tapered off into "points" to form switches when required. Following this, again, was shown a bit of what was probably the first iron railway in existence, the Merthyr Tydfil tramway in South Wales, with its rails of cast-iron angle bars nailed to rough stone sleepers. The collection included Stephenson's Stockton-Darlington railway, of 1820, the first ever operated by steam locomotives; the U-rail used by the Great Western of England from 1850 until about two years ago, and at one time employed on the Camden and Amboy; the cast and wrought iron round and oval "pot sleepers" so commonly used in Egypt and in India; and a very full and instructive assortment of

modern designs for track laid with iron and steel cross ties and longitudinal sleepers, not omitting, of course, those of the Georgs-Marien Verein itself.

IF we are to accept Tredgold's definition of civil engineering as the art of directing the forces of nature for the use and convenience of man, we may perhaps define military engineering as the art of directing those forces for the abuse and inconvenience of the other man. And here, too, the Germans were well to the fore. Few were the visitors to the Fair who failed to see the great Krupp exhibit, with its wonderful display of engines of destruction. When the delegates to the engineering congress visited the Fair, they were granted an exclusive visit to this building, which was, for the time, barred to all others. Here the great guns were manipulated for the edification of the visitors, who had opportunity also to disabuse their minds of the impression, if it existed, that the Krupp establishment devoted its energies solely to the manufacture of artillery, armor plates, and projectiles; for some very remarkable examples of its work in manufacturing propeller shafts, steel castings, locomotive wheels, and frames, etc., were also shown.

AT the north entrance of the United States government building was exhibited a specimen wicket from a movable dam of the Chanoine type, such as is now being built in the Great Kanawha river, West Virginia. This great work consists of the building of two fixed and eight movable dams, the latter all of the Chanoine pattern, in which the dam consists of a series of wooden wickets, each upheld by a separate iron prop and horse. Prop and horse are so jointed together as to form, when the dam is in place, an inverted V, which, when it is desired to lower the dam, is allowed to flatten out and lie in a straight line upon the sill of the dam; the wicket, of course, accompanying them and resting upon them in a horizontal position. The work, begun in 1875 and now nearing completion, it is under the charge of Colonel William P. Craighill, United States engineers, and Mr. Addison M. Scott, resident engineer.

A similar dam is in operation at Davis Island, in the Ohio river, and another is being constructed in the same river below the mouth of the Beaver. The object of such dams is, of course, to allow of slack-water navigation during times of low water, and, by lowering the dams out of the way, to afford unobstructed navigation, as if no dam existed, during high water.

THE French are our leaders in this respect, movable dams having been in use in that country for many years, and they have developed a great number of widely differing types in addition to the Chanoine; but owing, no doubt, to the much greater width and depth of our American rivers, our engineers have greatly improved upon their French prototypes in many matters of detail.

One of the most important improvements in the Chanoine type of dam (and this one, like the general design, is of French extraction), is the Pasqueau heurter. The heurter is the iron block or catch in which the lower end of the prop rests, when the dam is up. Prior to the introduction of Pasqueau's improvement, the feet of the props were dislodged from their seats in the heurters, by means of a long bar, armed with a series of lugs, one lug for each prop, and called a tripping bar. This bar extended along the length of the dam, close to the feet of the props, and was worked by gearing placed at the end of the dam. When this gearing was operated, the tripping bar moved longitudinally, and one of its lugs after another came in contact with its appropriate prop, throwing the foot of the latter out of its seat in the heurter and allowing it, with its horse and wicket, to fall. But the operation of such a bar, liable, as it was, to become tangled with weeds and stones, was exceedingly troublesome, even upon the narrow and shallow rivers of France; and upon our wider and deeper streams its use would have been practically prohibitory to the use of the Chanoine wicket. The Pasqueau heurter is so designed that no tripping bar is necessary. An up-stream

pull on the wicket by means of a chain draws the prop out of its seat in the heurter, and, upon relaxing the chain, the foot is guided away from its seat and, on to a long flat inclined plane, upon which it slides, allowing the prop to fall.

AN interesting illustration of the refinement of methods and of the rapid substitution of machine for manual labor which characterize modern civil engineering, was the noisy but undoubtedly effective dump-car of the Thacher Car and Construction Company, the abrupt snorts and shocks of which were apt to startle the unsuspecting passer-by. In this car the tipping of the body, and the resulting dumping of the material carried, are effected by a compressed-air cylinder provided upon each car and worked from the engine. A second and smaller cylinder, also worked from the engine, releases the latch by which the body is held in its normal position, and thus permits the dumping of the load. All the cars in a train may thus be dumped simultaneously, and, if desired, while the train is in motion, with an obvious gain of time as well as a great saving in labor. The car exhibited was a four-wheeled car holding 9 cubic yards, or say 40,000 pounds, but the company is prepared to furnish eight-wheeled cars holding from 60,000 to 80,000 pounds.

THE Ferris wheel, that landmark of the Midway Plaisance, came in for a special share of Professor Reuleaux's commendation. That eminent authority expressed himself as regarding the wheel as one of the finest examples he had seen of the skillful and economical adaptation of material to its destined purposes. It is gratifying to know that this movable Eiffel tower, as it might be called, has proved a very handsome financial success. Its designer, Mr. George W. Ferris, is, we understand, the engineer of the projected bridge to span the Ohio river between Cincinnati and Covington.

Those who are familiar with the Fair will not be surprised to learn that that other innovation in the matter of passenger transportation, the "moving" sidewalk, is *standing*, pending negotiations for its removal to another site. This remarkable and novel structure, which moved, not vertically, like the Ferris wheel, but horizontally, consisted, as every one knows, of two endless platforms, moving, one at moderate walking speed and the other at double that rate; the latter provided with seats, and the former with upright posts to assist passengers in entering and alighting. The combinations of movements necessary to an easy and dignified performance of these operations formed quite an interesting study to the uninitiated, and the writer can still see in his mind's eye the editor of one of our foremost engineering weeklies wrestling with the practical side of this problem. Unfortunately, this enterprise differed from the great wheel not only in the position of the plane of its movement, but also in the matter of financial returns. The company operating it claim that this was chiefly owing to delay on the part of the Exhibition authorities in furnishing power, so that instead of beginning to run at the opening of the Fair on the 15th of April, it did not go into satisfactory operation until about the 1st of July; and visitors to the Fair will remember that the sign, "The sidewalk is not running," was an almost daily spectacle. While it did run, however, it was unmistakably popular, affording, as it did, a delightful rest from the fatigues of Fair-seeing, together with a whiff of the cool breezes from the lake. It was run with 125 horse-power, and Mr. Schmidt, the secretary and consulting engineer, claims that at one time it carried six thousand passengers.

In comparing its financial results with those of the Ferris wheel, it is important to bear in mind that while the latter charged 50 cents per trip, the sidewalk charged but five cents; and that whereas a trip on the wheel meant two turns, neither more *nor less* (however sea-sick the rider might be at the end of the first), on the sidewalk "you could ride as long as you pleased."

Mr. Schmidt informs us that a movement is now on foot to construct a series of loops on this system in the business portion of Chicago. These loops will be elevated,

supported upon lines of single columns, and the whole structure will be light and ornamental. This may well be, for the weight of the rolling stock is inconsiderable when compared with that of the ordinary elevated railway with its locomotives. None of the loops will be over 1½ miles long.

A REFERENCE to the engineering features of the Fair, however incomplete, should not fail to include the Engineering headquarters, established by the associated engineering societies of the country and maintained at No. 10 Van Buren street, close to the business center and to the best means of reaching the Fair-grounds. These rooms, most acceptably presided over by Mr. Schmidt, and open to all visitors, domestic or foreign, who came accredited from any of the associated societies, were well supplied with the technical journals and other necessaries of engineering life, and formed a most convenient rendezvous for visiting engineers of all "persuasions."

PROFESSOR FRANZ KREUTER, of Munich, whose visit to this country last summer afforded so much pleasure to those who were fortunate enough to meet him, and whose wonderful command of English was a standing source of wonder to them, has submitted to the Institution of Civil Engineers a paper on "The Design of Masonry Dams," in which he proposes a new method of treatment of the cross-section. He divides the section, horizontally, into four portions, and gives, for each of these, formulæ for its dimensions and directions for determining its configuration.

At the same meeting were presented three papers, treating of gravity water-supplies in India, one at Tansa, with a masonry dam 135 feet high, or 7.5 feet higher than the great Vyrnwy dam erected for the water-supply of Liverpool, one at Baroda with an earth embankment 54 feet high, and one at Jeypore with an embankment of sand, without a core-wall, 61 feet high.

In the musically named Tuolumne river, in California, is being erected, for irrigation purposes, the La Grange dam, 129 feet high, 117′ 9″ wide at base and 360 feet long. It was begun in 1891 and will cost $600,000. Its ground plan is a curve, which, by one of the accounts, is of only 320 feet radius! The large stones used in its construction were cleared of débris by a water jet under a head of 75 feet.

FROM being one of the most backward of American cities in the matter of railway terminals, Philadelphia has, within the last decade, and notably within a year or two, come forward into the very front rank. The station of the Philadelphia and Reading railroad, at Twelfth and Market streets, recently completed, and that of the Pennsylvania railroad at Broad and Market streets, which was constructed some twelve years ago, but which is now being very greatly enlarged, are certainly far and away the finest railway stations in this country; and while, in respect of size and number of stations, Philadelphia is certainly exceeded by both London and Paris, it may well be doubted whether two finer stations than these exist anywhere. Both train-sheds are spanned by three-pinned arched roofs. The span of the Reading shed is 259 feet, while that of the Pennsylvania is 300 feet 8 inches. The latter is claimed to be the greatest single train-shed span in the world, although it is exceeded by the great spans of the Machinery Hall at the Paris Exhibition (362 feet 9 inches) and by that of the Manufactures and Liberal Arts Building at Chicago (368 feet). The Pennsylvania train-shed is 589 feet long (about 64 feet shorter than that at Jersey City) and contains sixteen tracks, with their platforms. The extension of the head-house, like the original structure, is of dark red brick. The newer portion is of conspicuously plainer character than the older, and many are the criticisms upon the resulting want of harmony. The Reading head-house, on the contrary, forms a very harmonious and imposing whole, although, to the mind of the writer, the light-colored brick, with its light-colored and highly ornamented trimmings, produces a less pleasing effect than the more sombre material of its great rival. Both terminals

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WHILE the canal, as a means of transportation for small boats, seems to have been fairly pushed to the wall by its smart competitor, the railroad, it will be seen that the case is far otherwise with the ship-canal. The two great interoceanic canal projects for the American isthmus are indeed not in a promising way toward early completion, but the Nord-Ostsee canal, to which we have referred, will no doubt be speedily pushed to completion, seeing that the "military necessities" of a great European power are behind it; and the past year has witnessed the completion of two great undertakings of this kind, little if any less remarkable, the Corinth and the Manchester ship canals. The former, like the great German canal, cuts through a peninsula, and is designed to avoid its tedious circumnavigation.

The Corinth canal, passing through territory of even far more ancient historical interest than that of Schleswig-Holstein, follows the line of a similar enterprise begun, but abandoned, by the Emperor Nero. It crosses the isthmus at its narrowest point and in a straight line. Its most remarkable engineering feature is its great rock cutting about 1.2 miles long and over 250 feet deep at its deepest point. Like the Nord-Ostsee canal, the Corinth canal will have locks at its ends only.

The Manchester canal is intended to circumnavigate, not a peninsula, but the dock charges at Liverpool and the railway tariffs from that port to Manchester, which town, by the construction of this work, has now made a sea-port of itself. It is one of the sad curiosities of our system of social economy that the furthering of the interests of one man or firm or corporation or community, too often involves the ruin of those of another, and this was notably the case between Liverpool and Manchester, the town authorities of Liverpool and the railway people fighting tooth and nail to prevent the consummation devoutly wished by the Manchestrians.

This canal, which cost fifty million dollars and was six years in building, is 35½ miles long. Extending, as it does, from an arm of the sea to an inland town, it is radically different in profile from the other two canals mentioned, which are at sea level at both ends. It leaves the estuary of the Mersey by means of locks at Eastham, on the left bank, six miles above Liverpool, and its tidal portion extends from this point 21 miles to Latchford. Here and at several points above, are locks. The total rise, from ordinary level in the Mersey at Eastham, to the terminus of the canal at Manchester, is 60 feet. At Barton, the ship canal is crossed by the previously existing Bridgewater canal, the latter being carried over the ship canal by means of a swing-bridge. The swing consists of a caisson, which, when swung open, is closed at its ends, as are also the ends of the canal communicating with it, so that each retains the water within it. The ship canal, above Latchford, constitutes the outflow of the Irwell and other small streams which are frightfully polluted by Manchester and other large towns; and vigorous measures are being taken, looking to their purification.

SOME remarkable work has been done on the New York Central and New York, New Haven and Hartford railroads in connection with the straightening of the line and the widening of the road-bed. On the New York Central, the Mott Haven station, a brick building 185 x 35 feet, with a tower 80 feet high and 19 feet square, was moved horizontally by screw-jacks, worked by hand, a distance of 50 feet, while on the New York, New Haven and Hartford, near Milford, Conn., 64 miles out from New York, the rails of a double-track section nearly two miles long, still spiked to their ties, were moved bodily, one track at a time, a distance of from 20 to 30 feet horizontally and raised from 6 to 9 feet vertically, being slid upon skids into their new postions. The work occupied a force of 261 men ten hours, including fifteen minutes for luncheon.

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MINING & METALLURGY

Conducted by Albert Williams, Jr.

UNTIL the statistics and estimates for the past year are available it is rather premature to draw conclusions, at least in detail, but it is safe to say that on the whole 1893 has not been a satisfactory year for American mining and its related industries. Many of the leading products will show a decline in the total output; nearly all have been marketed at much lower prices than in the preceding year; and with most of those items for which a gain in production will be reported, this will be more than offset by low figures for sales. All branches have been injuriously affected by the general financial depression; though in the case of gold-mining there have been counteracting influences which have stimulated its prosecution and in many places increasing the yield beyond the normal for recent years. Wages have been lowered and very many men thrown out of employment; yet, considering the severe tension, labor-troubles have been less frequent and intense than might have been looked for. The old year goes out and the new one comes in with a slightly improved feeling in mining circles as a whole; and with the promised revival in business at large mining will soon regain lost ground, except in those lines in which adverse influences not connected with the general prosperity at are work.

THIS Department is in receipt of a very fair and straightforward statement from the director of the "Correspondence School of Mines," at Scranton, Pa., in regard to comments made in the November issue of the Magazine upon an advertisement put forth by that institution, which was thought to be somewhat misleading, or at least liable to misinterpretation, inasmuch as, without qualification, it seemingly claimed that mining and prospecting could be "taught by mail." The instructor in charge of this branch of the course, who is of course not responsible for the wording of the advertisement, also sends an explanation. Besides these, a number of letters on the subject have been received from practicing engineers, instructors in technical schools,and intending students, for the question of the different and best means of acquiring an engineering or technical education is one that is always of wide interest.

Not to go over the ground anew, it may be stated briefly that the stand taken in this Department is simply this: Any education, however limited, for whatever application and however obtained, is better than none. The principle that "a little knowledge is a dangerous thing" is not true, though it furnishes a taking epigram. As to mining-schools, they all do good; more or less according to conditions. Where they are most likely to do harm is in claiming too much, and thereby giving students and graduates a false notion of things, best expressed by the slang term "a big head," which swelling is reduced by experience and time. In regard to the correspondence system no fault has been found here; on the contrary, it was much commended, within the evident limitations, and an examination of full sets of prospectuses bears out this view. But the wording of the advertisement was, as already pointed out, extremely objectionable. With that amended, there is nothing more to be said that does not apply in greater or less degree to all systems of technical education. In justice to the Scranton school, the most pertinent portions of the statement of its head, Mr. T. J. Foster, are here quoted:

Our advertisements are written in a general way, to make them as short as possible. In

writing them we take it for granted that every one knows that we cannot teach mining practice in a school,—only theory, and that practice and experience are necessary to successfully pursue any business. Through reading one of these advertisements you have fallen into the mistake of thinking that we propose to make miners of persons who are not actually engaged in mining. The regular mining schools may profess to make mining engineers or mine officials of the young men who study with them and take advantage of the summer classes held under their auspices, but I do not believe it can be done. I have never known of one of these young men after graduating who was qualified for anything but a subordinate position on a mine surveying corps or on the staff of a mine. I have known many of them, however, who, having supplemented their collegiate educations with years of mining work, have grown to be thoroughly competent mining engineers and mine superintendents, and I believe that a course in a regular mining school followed by three or four years of work in a mine is the best way to make a good mine officer. If, therefore, the regular schools cannot turn out mining engineers and mine officials without practice, we cannot expect to do so in correspondence schools, because it is not claimed for the correspondence method that it is as efficient as oral teaching or that it equals in results the regular methods of teaching. Knowing this, we make it a rule not to enroll as students people without experience. If any such write to us (there are very few who do so) for our circular of information, they find out on reading it that the school is only intended for men actually engaged in mining or those who are so situated that they are familiar with mining terms and mining. If such people write to us with a view of enrolling in the school, we discourage them from doing so. . . .

That we can educate practical miners and mine officers in the theory of mining and the sciences related thereto by correspondence, there is no question. Any student who will apply himself can learn by the correspondence method. It will take him longer than if he is in a regular school, but if he has the ambition and the habits of application he will get through. We have working miners over forty years of age among our pupils who two years ago could not add five and five together, who now thoroughly understand and can readily work out all the formulæ connected with mine ventilation. . . .

Our school is only intended for people actually engaged in the mining industry, its object being to furnish an education in the theory of mining and the sciences related thereto to men engaged in mining who are not able to obtain that education in any other way. . . .

T. J. FOSTER.

A VERY successful instructor, the professor of geology and mining engineering in one of our best institutions, who takes very high ground as to the qualifications of mining engineers, and who strenuously opposes the granting or use of the title "E. M." except to and by graduates of chartered institutions, writes:

. . . I am thinking seriously of abolishing the course for an "E. M." degree, as no course will give in four or five years all that an "E. M." should carry. We are specializing so much that I feel that we can go as far as a "B. S." and give a student the rudiments of mining or of metallurgy in four years—and no more.

I want to say that I differ from you in regard to "summer schools of mining." I do not propose to graduate *miners*, but *engineers*. We are so near the mines that the students go on trips every week or two, during three and a half years, and see all that there is to be seen. On vacations I get them places where they can get work in draughting and constructive work, but never in the mines as *miners*. I have them study outside matters, etc., but I have seen enough of students at summer schools to see that they learn nothing of any importance by a stay of thirty hours in any one place.

THE Ways and Means committee of the House, and indeed all members of both House and Senate, have a lively time in prospect in the discussion of the new tariff bill in its application to imports of ores, minerals and unmanufactured metals. Two points which are destined to be grounds for especially sharp contests are the provisions regarding importations of bituminous coal and of silver-lead ores. As to the latter, the situation is somewhat peculiar and the sentiment of Western miners is divided. The great majority of the producers energetically protest against a low duty or placing them on the free list; they would prefer to shut out the Mexican and other silver-bearing ores by a prohibitive tariff. On the other hand, those smelters in the Southwest which draw largely upon the Mexican ores, and

a certain number of miners producing "dry" ores, would be benefited by the encouraging of importation of smelting ores, but they are in the minority. Like all other tariff questions it is a matter of local self-interest and not of broad principle, and it is common to find lead ore producers who are free traders as to all else drawing the line where direct competition comes in. Meanwhile the low prices for lead, mainly due to apprehension of a reduction in duties on ore and metal, have compelled many large but low-grade lead and silver-lead mines to suspend operations, for with both lead and silver at such low figures their position has become critical.

THE relation of the World's Fair to the mining industry, discussed elsewhere in this issue of THE ENGINEERING MAGAZINE by Dr. R. W. Raymond, can be considered dispassionately now that the great show is over. All through the earlier stages of preparation and exhibition there were constant complaints from each of the States and Territories, and from each of the branches of mining, that they were not adequately represented, and on all sides the men responsible for the collection, handling, and presentation of the exhibits came in for adverse criticism. Yet as a whole the mineral display of this country was so much in advance of anything before attempted, and the interest taken by several foreign countries in bringing hither their fine displays was so marked, that visitors who previously had given little thought to such matters had their eyes opened. As a whole, the popular rather than the scientific interest predominated —as was perhaps fair, considering that among the viewers there were probably a hundred curiosity-seekers to one student.

ON the breaking up of every similar exposition there has always been, as was inevitable also in the present instance, a regretable loss of valuable material, brought together at so much expense and with so much effort. The loss is partly in the actual disappearance of specimens and partly in the dismemberment of collections which derive most of their value from their exhibition as units and for comparison. Some of the exhibits intrinsically most valuable find their way back to their original owners; but the great mass are not so returned. Machinery and available appliances are not lost, but the ores, minerals, etc., in part disappear unaccountably. In the present instance the efforts to maintain a permanent Columbian exhibition, for the California mid-winter fair, for State and educational institutions, etc., have doubtless had a beneficial influence.

THE great utility of accurate mine maps, wherever there are workings of any considerable extent, actual or projected, is universally admitted. So also is their absolute necessity fully recognized for mines, in which slight errors may involve danger to life and property. In all large mines it is of the highest importance to keep the surveys and plats well up to date, without regard to the element of safety, if operations are to be directed intelligently and to the best advantage. Mining men understand this thoroughly, though it is true that they do not always act up to their convictions, and it is hardly fair to assume that they are in general unwittingly careless or deliberately neglectful of the importance of the matter. This assumption has been made, in a manner involving a very serious accusation, by the editor of a valued technical exchange in discussing the recent Mansfield mine disaster (noticed in the December issue of this Magazine). Regarding this, a very competent authority, Mr. Richard A. Parker, of Marquette, Mich., sends us the following communication:

. . . The editor, sitting in his chair, with Argus eye sees his lecture on mine maps (excellent in its way and worthy of attention) and the mine disaster, and calmly and judicially proceeds to connect cause and effect; that is, no maps, hence the accident. I have been in the mine a number of times, and, without fear of contradiction, am confident that the accident was in no way connected with an absence of maps. The men were working at least 400 feet below the river-bed. At each line, 60 to 80 feet apart, fairly heavy backs of ore were left, to support

the mine, and even if "the miners had been digging away blindly and without direction in the bowels of the earth," so long as they did not run drifts up-grade so as to come out at the surface under the river their blind digging may have been and probably was a "loss to the operating company," but in no way did it, or *could* it, jeopardize their lives.

The cause of the filling of the mine has been argued in court, and it is stated as the Mine Inspector's belief that the trouble arose through the giving way of a timber shaft, located very close, I think within ten or twelve feet of the river; this may be so, as I have not seen the mine for a year.

The ore deposit stands nearly vertical in a bed of Huronian black slates, which have a course approximately north and south; the Menominee river is the east boundary of the property, and at this place has a course parallel to the strike of the slates; the dip is to the west, and about 75 to 80 degrees from the horizon. I incline to the belief that the extraction of ore weakened the hanging-wall slates, allowing them to sag, say, at the middle of the workings; this sag caused the slates to partly open at the surface, and when this was accomplished, it took but little time for a river of the size of the Menominee to wash out soft ore, and follow the cleavage of the slates down and into the mine. When I first examined the mine, I particularly laid weight on the method to be followed in mining the ore, for two reasons: (1) as the ore-seam was narrow (averaging 22 feet), by timber methods, a large proportion of the ore had to remain behind, and (2) for safety I advocated blasting the greenstone bluff tramming the rock by gravity to the mine and filling it.

SOME queer notions about mining get into print. A correspondent calls attention to an extreme instance of how the simplest statements become misunderstood and distorted in the course of handling by successive newspapers. In this case a Texas daily paper has got hold of a description of the steam-shovel method of iron-ore mining, from some authentic source, and after appropriating the original account, which is perfectly correct, is moved to add a few words of editorial comment. The Texas editor is much impressed by the wonderful economy of the steam-shovel system, especially from the statement that in one mine on the Mesaba range the cost of mining (apart from stripping and all other expenses) had been brought down to four cents a ton. He does not stop to learn or consider what are the conditions under which it is possible to use the steam-shovel, but jumps at once to a general conclusion and gravely observes that "as this machine handles as much ore in four minutes as one man can in a day"—which is quite true in the particular and peculiar case cited—"its adoption in the mines all through America may be looked for!" There is nothing so very amusing or exasperating in finding this sort of thing in a daily newspaper: the strange part of the story is that the whole article is reprinted without comment or explanation in one of the best of the technical journals, and that it has since been innocently borrowed by other papers and is now floating through the reprint columns of the press of the country, where it may possibly do harm by inducing false ideas of what is practicable in the economies of mining. As our correspondent points out, only mines of iron ore which can be laid bare cheaply by stripping the surface covering, which are soft enough to be attacked by a shovel (thus practically confining the system to certain red and brown hematites in limited areas), and which are thick enough vertically to pay for the removal of the surface material, are to be considered as within steam-shovel limits. With such statements in a technical paper as that above quoted, we may expect to see prospectuses of new iron-ore companies advertising the use of the steam-shovel *underground*, and quoting mining costs at four or five cents a ton, since down in the mine there would be no stripping charge—a most blissful state of things (for the promoter).

This is only one illustration of a very common tendency to seize upon phenomenal records, made under peculiarly favorable circumstances and usually by working on the very large scale, of mines or metallurgical establishments, and, by taking such records as of standard practice, apply them as a basis for estimates in other cases, where the conditions are wholly unlike or even prohibitive.

DURING the first six months of 1893 the total quantity of pig-iron produced in

Great Britain was 3,665,537 long tons,—an increase of 874,619 tons over the output for the corresponding period in 1892. This increase was partly due, however, to the lower standard of comparison caused by the falling-off resulting from strikes in 1892, and since the close of the half-year and up to a short time ago the rate of British pig-iron production showed a diminution. Toward the close of the year a revival of activity set in, and at the present time the industry is in an improved position again. The make of Bessemer-steel ingots in Great Britain during the first half of 1893 also showed a considerable increase (134,896 long tons) over the output for the six months of 1892.

THE English correspondent of the *American Manufacturer* (Pittsburgh), commenting on the statistics of the British Iron Trade Association, from which we obtain the foregoing figures, deduces an interesting comparison as to the relative positions of England and America in regard to the iron-ore supplies necessary in both countries for iron and steel production, from which it appears that while of the total consumption of iron ores in the United Kingdom the foreign ores are more largely depended upon (25 per cent. against 12 per cent. ten years ago, or about double), in this country the furnaces are increasingly drawing upon domestic ore supplies and becoming correspondingly more independent of imports. The iron-ore production of the United Kingdom has steadily declined during the past four years, while that of the United States has gained as steadily. In 1890 the two countries were on a level as to home iron-ore production, but in 1892 our iron ore output had gained about 50 per cent., and was then about 5,000,000 tons ahead of the domestic ore production of the United Kingdom. Of course it must be remembered that in this country imports of foreign ores will always to a certain extent depend upon tariff legislation.

IRON-ORE mining in the United States has suffered in common with other cognate industries during the "hard times" and the general depression in business which set in last summer and from which the country has not yet recovered. Not so much has been heard or read of the losses, enforced idleness, privations and hardships of the iron miners as in the case of the silver miners, yet the last few months have borne with great severity upon thousands of the former, and especially in the iron mining districts of Michigan and Wisconsin, where so many men have been thrown out of employment and had to face the rigors of winter in an almost destitute condition, so that supplies of food and clothing from charitable sources outside were necessary. These men, a large proportion of whom are foreigners, who have been working at low wages and with little chance to lay by savings from their wages, and who are generally lacking in the adaptability or opportunity to turn their hands to other work and unable even to leave the iron regions, are more to be pitied than the silver miners. These latter have suffered much from the suspension of so many mines, but they have been able to meet the situation on better terms; many have found employment in gold mining, others have left the idle silver camps, and while there are still many of this class unemployed there are less of them out of work than was at first anticipated.

IT is a serious question whether in the United States the natural resources of the country have not in some directions been developed too rapidly. There are political economists who assert that there can be no such thing as over-production, in the sense that there can never be too much of the good things of the earth; but the dictum of the theorists, while very pretty as an abstract generalization, is small consolation to the producers, whether miners or others, when they find that the market will not absorb any more of their products on terms profitable to them, or at all. This very case of the iron-ore industry of the Lake Superior region is in point. Making all allowance for the disasters attributable to bad financiering and to unexpected setbacks due to the stringency of

the money market, it certainly does look as if investment and development, tempted by the enormous mineral resources and possibilities of the upper iron districts, had been going ahead entirely too fast. Profits per ton of ore having been cut down by sharp competition to narrow margins, producers have been driven to the heaviest possible outputs individually in order to keep up the total net incomes, a course which has naturally resulted just as the similar policy (for which there seems to be no successful alternative in restricted production by agreement) has in the case of copper and coal mining.

FOR examples of heavy output in iron smelting, the records of the blast furnaces of the Edgar Thomson steel-works, the largest plant of the kind in Pennsylvania, are usually referred to. As Mr. John Birkinbine, in the last of his series of articles "From Mine to Furnace," in *Cassier's Magazine*, justly says, probably no better illustration of the development of the blast furnace can be offered than is given by the records of these works, concerning which he presents the following memoranda: The plant consists of nine blast furnaces, which can produce together over 2000 tons of pig-iron daily, and which have averaged a total output of between 1500 and 1600 tons per day. One of these furnaces, which completed 37 months of its present blast in April, 1893, had made in that time 370,000 tons of metal, and was running at the rate of 11,000 tons per month. The furnaces are 80 feet high with boshes 20 feet, 22 feet and 23 feet in diameter, and 90 feet high with boshes 22 feet in diameter. Thirty large blowing-engines supply blast for this group of furnaces. One hundred and twenty boilers furnish steam to drive the blowing-engines, the pumps and hoisting appliances, and 24 pumps are in constant use furnishing water. Thirty-three hot blast stoves heat the air supplied. One of these furnaces has reached the remarkable output, for a single day, of 623 gross tons of iron; in a week one furnace stack has made 3023 gross tons, and in one month one stack produced 12,800 gross tons; that is, in one month, one of these furnaces produced fully as much iron as twenty-five years ago would have been turned out in one year from the best and largest of the American blast-furnaces.

AN interesting bit of metallurgical history is contributed by a writer in *Industries and Iron*. It relates to Sir Henry Bessemer's famous "sun furnace," which, as the writer says, was "possibly well-nigh revolutionizing the world, let alone the science of metallurgy." The description is not quite clear, but it certainly is readable: "It was to attain a temperature of nearly 60,000°, and therefore fuse anything and everything; and I was assured that it would have achieved its object but for the stupid fault of an Essex lens-maker. The 'sun furnace' consists of a wooden building 35 feet high and some 12 feet square. A few feet from the ground a large inclinable mirror for catching the rays of the sun is fixed; the rays are reflected from this mirror on to a number of powerful superimposed lenses above, which, by a simple arrangement, were to throw the enormously concentrated rays upon whatever object might be in the crucible below. Such was the mighty plan, but the manufacturer of the upper glasses, instead of turning them out uniform, made them all different, and thus the focus was spoiled. The work and anxiety in connection with this sun furnace was so great that its deviser did not care to go over the ground again, and there the peculiar furnace remains—a remarkable monument of what might have been."

THE steadiness of the tin production in Cornwall is shown by the following figures: In 1892 the output was 9251½ long tons, as compared with 9353½ long tons in 1891. The value for 1892, however, was slightly higher than in 1891.

For the year ending April 30, 1892, Banca and Billiton (Dutch East Indies) produced 5755 and 6384 long tons respectively, or 12,139 tons together. These islands have been slowly increasing their output from year to year, but the rate of increase is fairly uniform as well as small.

Meanwhile, where is our American tin?

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

THE effects of cyanide potassium on iron and steel are interesting to a high degree. Machinists use two forms of this chemical—the ferro-cyanide, or yellow prussiate, and the fused white cyanide, with the iron removed. The effects of these two forms seem identical as far as the hardening of iron is concerned, and if they differ at all in effect, it is in the superior degree of strength possessed by the white cyanide. That a film of this substance melted upon the surface of a red-hot iron article can cause it to harden on the surface, which otherwise would remain soft after quenching, is a marvelous and a valuable fact. The question of how this is accomplished cannot be absolutely answered, but it can be conjectured to a probability. Cyanide potassium has a close affinity for sulphur—so great, indeed, that it will absorb that element from tarnished silver, for which metal sulphur, in turn, has so great a liking that its most attenuated vapors collect on spoons and other articles of plate from the atmosphere, forming a sulphuret in the form of a black coating on the surface. A great many of the smaller sizes of iron screw rods are coated with copper and some of them, at least, are merely treated in a solution of the sulphate of copper to produce this result. In this treatment the sulphuric acid leaves the copper in the metallic condition on the rod and attacks the surface of the iron. Hence there always is a sulphate present under the copper coating thus produced on screw rods.* In case-hardening articles made from coppered screw rods of the kind named it is found that animal charcoal has not a sufficient effect on so much of the original surface as has had no cut taken to remove the influence of sulphur from it, but where there has been a considerable amount of that surface removed to a reasonable depth and has thus exposed the iron beneath the influence of the sulphur, this charcoal prepares it to harden in a satisfactory manner. Now it is found by experiment, where the surface of such a screw rod does not become hard after treatment with animal charcoal in the usual case-hardening process, that cyanide potassium will neutralize the sulphur and assist this kind of surface to become hard. This substance does not work very well when mixed with the animal charcoal in the hardening case, because it does not spread freely but clings to the charcoal in a manner not clearly understood, and so closely that the metal under treatment receives but little, if any, of it. If the pieces be touched where needed by a piece of the cyanide as they are taken from the box to be quenched, it will serve. This is often not practicable, however, as in the case of a great quantity of small pieces which would cool too quickly for such treatment. In this case it is suggested that a quantity of cyanide be dissolved in water making a strong solution and articles be quenched in it.

HEATING steel articles such as small tools in a crucible filled with cyanide potassium is certainly bad practice. There is no certainty that all will be equally hard, for this substance has very treacherous habits with tool steel. Again, if articles be kept very hot a considerable time in a bath of this character the surface will melt and a thin layer of it will flow off. The writer had this experience with a number of small taps and found a button of steel in the bottom of the crucible after the taps were proved to have diminished in size. Cyanide of potassium is a very valuable sub-

*See answer to "B. V. M." in Machine-Shop Notes, in THE ENGINEERING MAGAZINE, June, 1892.

stance, but it is the most poisonous thing a machinist is likely to meet in his work.

WHILE the designing of drill jigs is among the elementary things in shop engineering, there is in the construction of them much experience that will serve in milling fixtures and in designing the higher branches of machinery to do automatically and sequently complete operations. There often is need of something that approaches genius to arrange a piece in a jig so that all the holes required in it may be drilled with one setting and that the piece may be secured by a novice with the certainty that it will not be sprung out of shape in the least. In these two particulars there is no difference between a simple jig and an elaborate perfecting machine.

WE are free to say that our experience shows us that the flesh side of leather is the best to place against the pulley when such leather is used as a belt. We know this to be contrary to the most usual practice, but this general practice is due to the ideas of belt makers rather than to those of belt-users. Traction is greater where the surface is elastic and has a clinging tendency than where it is hard and smooth. This is because this kind of surface clutches the pulley more securely by being pressed into all the pores and interstices of the metal or varnish. If a smooth hard belt were desirable, then of course a thin metal band would be the best thing. This needs no argument to prove its absurdity.

THE shafting in many shops has many things to condemn it. As a rule it has too much length between the hangers. Now no shaft of a size likely to be hung in a machine-shop should have its hangers farther apart than eight feet. In fact that distance is about right ordinarily. A small shaft, $1\frac{1}{16}$ inches in diameter, will be well enough supported that far apart for usual conditions. It will neither sag nor be sprung by correct belting out of alignment, and a shaft quite large, $2\frac{15}{16}$ inches, will have a sufficient number of supports at eight feet intervals to carry its great weight, that of its furniture and the belt strains. It is farther found that couplings are quite often placed at too great a distance from the supporting hanger. They should abut the hanger closely and never should be farther away in any ordinary case than twelve inches. Shafting is regularly made in sixteen-feet lengths, hence if the hangers are eight feet apart, all the coupling will be of the same distance from them. Then if the extreme end of a line of shafting be set out from the first hanger about one foot, the middle of each remaining coupling on that line will be one foot from each second hanger.

WHEN flanged couplings are forced tightly on the shaft, and keyed carefully, so that the keys bind radially outward and inward and do not fit on their sides, they are good couplings. These conditions, unfortunately, do not prevail to the same extent that flanged couplings do, and they sometimes give trouble of a very grievous kind. At first where such couplings are badly fitted, shafting will not run true. Afterward the line will spread because the shaft will slip out of the couplings endwise, and again, the shaft will grind out the coupling, wear out the key and its seat, and ruin in a few days what it costs much money and trouble to mend. Compression couplings of a kind that wraps the shaft are the best and cheapest. Other couplings that compress by short clamps do not seem to be satisfactory under heavy duty. There are, however, a great many good couplings. We have been looking for many years for some one to invent a coupling to fit the inside of the hanger box so that the spaces on a line of shafting that at present are occupied by couplings shall be saved, but the proper thing has not yet been found.

UNFORTUNATELY, the making of machinery is not compatible with cleanness, as the term is understood in a parlor or an office. Consequently a machinist gets his working clothes and his hands very dirty. Overalls and such garments can be made to protect the clothing to a great degree, but for the hands and arms there is no practicable protection. The only thing that

can be done is to clean the dirty hands and arms after work, and that is no easy matter, for soap and water does not remove all or even a great part of the grime. We do not pretend that the method indicated below is the best one for removing the shop dirt from a workman's hands, but it is the best we know of and we are certain that it is efficacious and safe, which latter some of the chemicals sold for this purpose are not. After stopping work, do not wipe the hands with any hard cloth to help remove the dirt, for that merely rubs it into the pores, and makes it all the harder to reach and get out, in fact, do not rub the hands with anything at all. Do not use sal soda or any other alkaline compound except soap. Do not use coarse sawdust or sand, as both of them act the same as a coarse cloth. The first thing to be done is to take water and strong soap and make a heavy lather. With this, wash off, with much rubbing with the palm, all that can be got at by this process. Then, having procured some fine ground pumice stone, which still is not so very fine but that it has a palpable grit in it, make another lather from good mild soap and clean new water, for it is worth some trouble to get clean and have smooth, soft hands. When this lather has been well rubbed into the skin, take of the pumice about one teaspoonful at a time, and scour well each place where any dirt remains. The palms for instance, the thumbs, and the fore fingers, where the pores are deep, and the knuckles, all must be scoured well. Use plenty of water and but little soap, and after awhile no soap. Finally rinse well with clean water. Do not use gritty soaps, as they are not good and cost too much. Do not use warm water.

This rather troublesome treatment will take off all the dirt and make the skin soft and smooth. Buy the pumice at a painter's-supply store, as it will cost less there than elsewhere.

LET us look at this matter of the contract system of manufacture. Are the workmen benefited by this system? Or is the owner benefited? Working for a contractor, a man has to serve two masters—the contractor and the employer. He must earn a profit for his employer as large as he would if he worked directly for the concern, and one for the contractor also. When the price to the contractor is reduced for work under his contract, no one is so unsophisticated as to believe that he stands any part of it, for every one knows that he at once cuts his workmen correspondingly and generally so that he gains a small fraction here and there to make his profit, if anything, greater than before. It may be asserted that contractors improve their tools and processes and thus cheapen the manufacture of their product. We admit that in one or two cases in our experience, some years ago, this was the case. But in these cases the tools were paid for by the employer, and the contractors were given the use of them free of expense, and only were required to produce them in inventory each year and at the termination of contracts. It cannot be expected in truth that a contractor would or could pay for many new tools, because he could not know that he would be awarded another contract at the expiration of the one existing when the tools were made. We know of one case where a contract for $1500 worth of work stated that all tools made to do work should be paid for by the contractor, but should become the property of the concern at the expiration of the contract without further remuneration. The tools in this case cost about $400, yet the contractor made a good profit, principally because the superintendents, not owners, who gave the contract were not industrious enough to get facts to base their calculations upon, but on the contrary merely guessed at the prices. When, however, a great profit was shown in favor of the contractor the cost of the tools which were made in the tool-room of the concern was recalculated and expanded so as to absorb all the objectionable profit and make a respectable showing on the books. Such treatment of contractors is very common, and discourages the building of all tools not certain to yield a good profit from a very small outlay. In many instances a contractor will fail to get a renewal because of an underbid, and the

probability of this also discourages improvements in tools. Again, employers often remove a contractor for various causes, and in many cases after studying it they discontinue the system altogether. Hence there is but little encouragement to contractors to improve tools and processes, or in fact do anything after a "cut" but cut his workmen in turn.

WHAT an owning employer makes or saves by letting his work out to contractors is past finding out. It is possible that he may get his work cheaper than by day's work where his superintendence is careless or inexperienced, but that is doubtful in most cases. The loss he sustains, however, in giving contracts, rather than piece work direct to his workmen, is much greater than the profits gained by the contractor, because in this case there is every encouragement toward the improvement of tools and the processes of manufacture, and in this case also every one of the piece workers also is interested and gives many valuable suggestions to forward his interest as well as his employer's. Employers lose control of their men and their work where it is "contracted" out, and this leads to insubordination and to waste of materials. Every factory-owner whose work is done by contract knows that every effort he makes to get at the exact details of his work is circumvented, or he is given statements in which he has no confidence. Again, the percentage of material supplied compared to parts finished is too high when compared with other systems of manufacture. Every factory-owner that has his manufacturing done by contract, knows that his men are not loyal to him and that they dare not be so in preference to being true to their contracting superior. With the system of piece-work directly between the workmen and the owner, it is obvious that there is required more and better superintendence to fix just and equitable prices, to see that men actually work for what they get, and to inspect the production for quantity and for quality. But, under this system, the owner deals directly with his men to the benefit of both. His assistants, being salaried men, can be well paid with a fraction of the savings gained over day's work or the contract system. More proper discipline may be maintained and more proper freedom felt under the direct piece-work system than under any other wage system. The owner knows or can know just what his output will cost, and the men know that all extra efforts will increase their own earnings as well as the profits of their employers. Under this system it pays to be just and fair. No wise employer will cut a smart man's price who makes high wages any more than he will give a slow man an extra price so that his snail-pace shall not affect his pay. The prices should be set at the average and after they are permanently determined should be set for a year or until a change is made either in the construction of the piece or in the tools and method of its manufacture. Often a bright man will devise small tools or improve others so that his output is increased materially. In such cases he certainly is entitled to all the benefits derived from his ability until the expiration of the year or other time agreed upon, and even afterward he should receive a recognition for it.

THERE is really nothing to be said in favor of the contract system of manufacture except from the standpoint of the contractor. His position, like that of many another middleman, is more benefited by his removal than by being either sustained or instituted. The only excuse for his existence originally lay in the crude ideas of manufacture existing among owners before the era of improved tools such as jigs and special fixtures, by which work can be duplicated cheaply, expeditiously, and accurately. Within a period ending in the eastern United States about 1876, there were too few men capable of doing good work cheaply, and such men as were capable were in demand and could find situations on favorable terms to manufacture by contract, in quantities, work at prices that surprised their employers but which paid them well. This period now is past, for there are plenty of reasonably able men, known as toolmakers, who can devise and duplicate jigs and fixtures of standard de-

sign as well as any of the marvelous contractors who graduated from Colt's armory in its prime.

THE confidence with which foreign manufacturers accept American methods and machinery, and the uniformity with which this machinery satisfies that confidence by fulfilling the expectations of the buyers, is most gratifying to those who export as a business and to the engineers who design it, and it is a matter of pride and glory to the American people. Among the latest triumphs in this line is the adoption of the American system of kiln drying by some of the leading lumber people in Western Europe. This is not like the baking of wood in ovens as in the old system, but the forcing of a blast of hot air through the piles of lumber properly housed. In this way all the moist vapors evaporated from the wood are driven away by a current of dry atmosphere from fans operated by power. It is said that woods dried in this manner are improved in every way, that they are more evenly dried, and that the grain (which is the element of beauty in woods) is much improved by the process. The fact that it prevents checking would in itself be a sufficient advance over other methods of drying. I am indebted to the Buffalo Forge Co. for a letter from a foreign purchaser who writes: "The outfits were placed by our own hands, following your specifications, and we were not put to the expense of securing an expert for the purpose. The whole arrangement is very simple, and easily managed, besides being a money-saver in operation. We are able with the kiln you sent us to dry soft woods in three days, and hard wood in five days; that's good enough for any one." Testimony like this emphasizes the growing appreciation of American machinery in foreign markets.

"MR. BLUNT, we will have to get a new spindle for the thirty-inch lathe next the boring mill. I suppose we can order from the maker cheaper than we can make one."

"Headstock spindle?"

"Yes, sir."

"Isn't that the lathe the new chuck is for?"

"It is; yes, sir."

"What happened to it?"

"The new chuck needs a flange to fit it to the spindle. We found a suitable pattern and cast one yesterday. The man who was boring it out preparatory to cutting the thread in it, bored out the spindle also, so that when he had it almost to size the thin shell broke and the whole thing fell down on the shears of the lathe and rolled to the floor."

"One of my men did that! Who was it?"

"Mr. Means."

"Why was Mr. Means entrusted with such a job as that, Mr. De Gree?"

"He was anxious to do it, having done a similar operation at the Institute. He is willing to pay for the damage."

"Damage!" said Blunt,—accenting the first syllable;—"can he pay for the delay! That lathe was made by a concern now out of business, and we will have to make a spindle ourselves, and it will take four days, and another lathe from the work. Oh dear! Mr. De Gree, hereafter do not push forward any young man beyond his knowledge of the trade, no matter what his antecedents may have been. I cannot go to my customers with poor work and say to them: 'This is a botch job and I know it, but the young man who made it is a scion of one of our first families.' A customer would not stand that, he would tell me: 'What do I care who made this thing? If it is good I want it, but if it is bad I won't have it.' I am glad Mr. Means has the courage to be industrious and to get the trade practically by experience. I honor him for it. Of course I will not make him pay for the accident any more than any other boy working under instructions, but it will make us more careful what kind of jobs he receives."

CURRENT TECHNICAL LITERATURE

RESISTANCE OF SHIPS AND SCREW PROPULSION. By D. W. Taylor, Naval Constructor, United States Navy. New York and London: Macmillan & Co. [Cloth, 8vo, 234 p. $3.75.]

THE general purpose of this work is the development of formulæ and methods for the determination of resistance and indicated horse power, and for the design of screw propellers. Chapter I contains the treatment of the subject of resistance, embodying the duly credited results of Froude, Tidman, and others. As a result the author proposes a formula involving the 1.83ths and 4th powers of the speed, and two conditioned constants, precedents for the determination of which are given at a later point. In Chapter II the theory of the propeller is taken up. Propeller theories in general may be divided into two classes: (1) Those in which the quantities considered are the amount of water acted on, and the acceleration communicated to it, with the various velocities involved; (2) those in which the quantities considered are the geometry and velocities of the propeller, and the amount and distribution of pressure over its surface. Neither class of theory is satisfactory, for the reason that in (1) we cannot accurately determine either the amount of water acted on, or the acceleration communicated to it, and in (2) we cannot accurately determine the amount and distribution of the pressure. Propeller theories have usually been of the first class. The late William Froude in 1878, however, published in the transactions of the Institute of Naval Architects a paper outlining the basis for a theory from the second standpoint. No attempt was made to develop this into a working theory, and, with occasional reference by other writers, the subject so remained until the advent of the present work, wherein we find the theory from this standpoint carried out into working form.

The geometry is introduced by means of certain functions of form called characteristics. These are made independent of dimension, and their values for a proposed form of developed blade are tabulated for all usual ratios of diameter to mean width. It then becomes possible to express the performance of the propeller as a function of the dimensions, the velocities, the characteristics, and two conditioned constants. One of these is the tangential or frictional resistance per unit area, and the other the normal pressure or head resistance for the same unit. The application of these formulæ to the results of tests of propellers will then serve to furnish data for the necessary control of the constants, and the formulæ thus become appropriate to the design of propellers intended to work under conditions similar to those from which the data were drawn.

Chapter IV takes up the analysis of speed and power trials. The methods used are highly ingenious and original, and furnish an analysis in greater detail than by methods hitherto in use. The results obtained are as follows: The assumption and consequent elimination of the initial engine friction; the determination and elimination of the load engine friction; the determination of the power involved in the skin resistance; the determination of the power involved in the friction and resistance of the propeller; the determination of the power involved in the wave making resistance; the determination of the amounts of power involved in the thrust deduction and wake gain; the wake factor and the various efficiencies also appear in the process of analysis.

Chapter V takes up the powering of ships. The various approximate methods are explained and their limitations noted. Froude's extended law of comparison is then fully explained, and tables and diagrams for its ready use are provided. The author gives also what is termed an independent estimate method, involving the

use of the formula for resistance deduced in Chapter I, and certain assumptions as to the efficiency of engine and propeller.

The author is unnecessarily severe on the admiralty $D^{\frac{2}{3}}$ constant method, and on other similar methods involving an area function of the ship, and the cube of the speed. It is readily shown that if the constants are taken as *equal* for *similar* ships at *corresponding* speeds, the law of extended comparison is exactly fulfilled, and the same results are obtained as by its use in the form recommended by the author. The selection of the constants in this way is in fact simply one form of the many in which this law may be put.

In Chapter VI the design of a propeller is shown in detail, and additional characteristics are derived by means of which the stress on the root of the blade may be determined, and the design for strength effected.

As a whole this work marks a distinct advance in our knowledge of the subject, and in our means for the treatment of the various problems of design. From the free use of analytical methods it is a work which will most strongly appeal to those interested in the mathematical and theoretical development of the subject. The practical applications are put in such form, however, that no especial knowledge of higher mathematics is necessary for their execution. Throughout the work, moreover, tables are freely provided as aids in the practical carrying out of the operations involved.

The reliability of these methods and their general superiority over those more commonly in use involves a question which can only be determined after a considerable amount and range of application. In general these methods involve a greater number of variables than those now in use, and we should therefore expect that with equally good control for the constants involved, they would give more accurate results.

In any case it must not be forgotten that when formulæ and methods involve the use of constants whose value must be controlled by the results of actual experiment, the use of such formula or method beyond the range covered by the experimental data is accompanied with uncertainty, and should be avoided. It follows likewise that the longer such formula or method is used, and the more data there is available for its control, the more trustworthy will be the results obtained by its use.

W. F. DURAND.

THE COAL AND METAL MINERS' POCKET-BOOK OF Principles, Rules, Formulæ and Tables, specially compiled and prepared for the convenient use of mine officials, mining engineers, and students preparing themselves for certificates of competency as mine inspectors or mine foremen. Fifth edition, Revised and enlarged. Illustrated. Scranton, Pa.: Colliery Engineer Co. [Cloth. 12 mo. 565 p. $4.]

THIS pocket-book corresponds in the main to Trautwine's and Haswell's civil engineering pocket-books, giving much of the common-stock material that is applicable in all branches of engineering, omitting that which does not so apply in mining, and adding features of special interest and utility to mining engineers that are not given at all in other compilations of its class. The departure in method consists in the introduction of a relatively large amount of reading matter, so that the work is not merely a collection of tables and formulæ, but, in part at least, serves as a descriptive treatise.

The chapters on mathematics and mine-surveying which occupy the first 74 pages are admirable in point of simplicity and clearness, and are amply sufficient for the everyday requirements in mine work. It might be advisable to add a special section on the class of surface work performed in locating mine boundaries and establishing them when applying for United States patent on mineral ground, as is done by the United States deputy mineral surveyors. For the refinements of surveying, as in running long and difficult tunnel connections, something more is needed than space allows. But the omission of such points simplifies the subject for the ordinary use of the miner. The tables of weights, measures, money, strength and weight of materials, etc., are of the usual form. The chapters on wire ropes and chains are very complete. A short section is devoted to the principles of mechanics.

The chapter on colliery management is the most important feature of the work; and that portion of it on "Methods of Working" contributed by Mr. W. S. Gresley, is of especial value from its logical exposition of different systems as applied under varying conditions. This is really a monograph in itself. Ventilation, as might be expected in a work intended chiefly for coal-miners, is treated in much detail and with thoroughness. Then follow chapters on hydrostatics, hydraulics, compressed-air power-transmission, mine railways, friction of mine cars, colliery machinery, steam raising, etc. Under the head of miscellaneous are included a variety of data, location of mine faults, application of electricity in coal mining (which, by the way, is hardly up to date), glossary of mining terms, and trigonometric and logarithmic tables.

Whatever weakness may exist in the formulæ and tables can only be developed in the course of practical use, and cannot be detected on a cursory examination. The careful editing and the general excellence of the typography lead one to hope that the type-setting and proof-reading may be depended upon—a most essential point; for nothing is more vexatious than to run across an error in a figure or equation when referring to a work which has often to be trusted to as the court of last resort.

Those who have had frequent occasion to use any of the engineering pocket-books cannot have failed to remark one exasperating peculiarity, which seems to be inevitable no matter what pains have been taken by the compilers to make them complete; and that is that the one particular thing that it is desired to find out, in order to solve the actual problem in hand, is just the thing missing, while any amount of irrelevant or almost irrelevant matter is liberally bestowed. This is something that cannot be altogether avoided. The best that the compilers can do, if they understand the practical requirements (as the compilers of the volume under notice seem to do), is to keep in mind what the user will be most likely to seek for, and to provide for all reasonably probable emergencies. In the present case, so far as can be judged by a brief inspection, the selection of material appears to have been made judiciously and with a view to the real needs of the user. Within certain limitations as to scope, a fair degree of completeness has been reached. The compilers cannot be expected to condense a library within 565 pages, and they evidently have not padded out with matter simply to make a plausible looking book, but have shown discretion in pruning off much of the useless matter which so often encumbers reference books, in order to make room for what is of value. Miners, as a rule, do not need to go very deeply into the refinements of engineering, but they require information of a kind that is distinct and apart, at the same time having to trench somewhat upon the ground belonging to the civil and mechanical engineers.

It may seem captious to find fault with a work so excellent in other respects, but in common honesty exception must be taken to the statement in the preface that "metal mining is treated as comprehensively as coal-mining." The fact is that there are just eleven pages (pp. 182–192) devoted to metal mining proper. Incidentally, of course, some of the matter regarding colliery work applies to metal mining as well, and this is true also of the sections on mathematics, physics, machinery and some miscellaneous data. But the compilers, doubtless influenced by the local environment, have devoted their energies mostly toward meeting the requirements of coal-miners, and this has resulted in crowding out and slighting an equally important division of the subject as indicated in the title. The problems in metal mining may not be more difficult or urgent than those presented in coal mining, but they assuredly are more complex and variable, the conditions being so much more diverse.

Advantage may be taken here of the polite invitation of the publishers to "call attention to the omission of any data that they [readers and users] may have felt the want of, so that it may be inserted in future editions," to venture a suggestion or

two. It would not add much to the bulk and the cost of the Pocket-Book to insert concisely prepared sections on: Rocks, their composition, character, relations to ore deposits, behavior in drilling, blasting, as building material, etc.; minerals, composition and determination of the few principal ore and gangue minerals (physical; chemical, and blowpipe tests for the useful minerals and mineral substances); working of quarries; well-boring and location of petroleum, brine, gas and artesian wells; hydraulic and other varieties of placer mining (for which there are rules and formulæ available); explosives; systems of blasting; power drills; locating adit and drainage tunnels; without going into metallurgy proper, to give the underlying principles of ore dressing (classification and concentration), as a preparation at the mine for further treatment; mine accounts; forms of superintendents', inspectors,' and experts' reports; bibliography of standard technical literature bearing upon mining, etc. The book could stand an additional hundred pages without becoming too bulky, being printed on extra thin paper.

ALBERT WILLIAMS, JR.

CONTINUOUS CURRENT DYNAMOS AND MOTORS: THEIR Theory, Design, and Testing. With Sections on Indicator Diagrams, Properties of Saturated Steam Belting, Calculations, Etc. An Elementary Treatise for Students. By Frank P. Cox, B. S. New York: The W. J. Johnston Co., Limited. [Cloth, 12mo, Illustrated, 271 p. $2.]

THIS is a new text-book upon a subject of prime interest both to students in electricity and to electrical artisans and one upon a knowledge of which more depends in the successful handling of electrical machinery than at first sight appears. It has been long held by the reviewer that an apparatus cannot be intelligently handled until the operator thoroughly understands its construction and the part which each element in the apparatus plays in the economy of the whole. While our best treatises on this subject could offer nothing better for a long time than a collection of empirical formulæ and "rules of thumb," the science of electricity and magnetism has so far advanced within the past few years as to enable us to substitute scientific methods for empiricism, and we now have a number of treatises which develop these subjects by rational methods. Most of these, however, are for the advanced student or specialist and involve a knowledge of the higher mathematics, which at once places them beyond the reach of those not thus equipped. With few exceptions, all attempts to popularize these subjects, to bring them within the reach of a larger circle, have failed, at least in part, because the author, in attempting to break away from the more scientific nomenclature of the mathematical treatises, has also in a measure departed from scientific methods.

In the present volume the author has very successfully maintained a medium course and has given us the best that has thus far been published for the classes intended to be reached. Mr. Cox impresses one with the idea that he is practically familiar with the subject of which he treats and gains the confidence of his reader at once. To a charming style is added that very rare ability to impart to others the knowledge which he possesses; his explanations are clear and concise and divested of all useless verbiage. His method, too, is the approved one, viz., strictly scientific and mathematical, relying for simplification solely upon clearness of diction and a strict adherence to the object in view.

The book is by no means intended for the first beginner, but presupposes a more than speaking acquaintance with electricity in general and motors and dynamos in particular, and a mind already trained to mathematical analysis and synthesis as expounded in algebra and geometry.

The first four chapters are devoted to a brief review of the electrical units and the general principles of the machines, and may be considered as an introduction to the subsequent portions. With the fifth chapter commences the mathematical discussion which leads to the determination of the various dimensions. The criticism upon this is that it seems at first a little abrupt by contrast with the purely descriptive matter which precedes it, but this is only apparent, however. With Chapter VI the difficulties experienced at the first

plunge into mathematics are cleared away, and from this point on the reasoning in general seems exceedingly clear and logical and will be followed without difficulty. Throughout the book the author has recognized the fact that some minds are more receptive to one method of reasoning than another and where admissible, he has given more than one method of reaching results. Thus in Chapter V he gives both Kapp's and J. E. Hopkinson's method of determining the magnetic circuit, and in Chapter VII, under the head of the dynamo as a motor he gives two methods of equating for torque. With Chapter VII ends the discussion of generators and motors in the abstract, and with Chapter VIII begins the illustration of the previously enunciated principles by their application to concrete examples. The author has been particularly happy in his methods here. Starting with the problem to design a 200 light dynamo with difference of potential of 110 volts at speed of 1500 revolutions, without further limitations, he follows out both the mental and mathematical processes by which the desired result is reached, first for two pole and then for a four pole fields with Siemens and Gramme armatures, thus showing side by side how identical results are obtainable by the different methods now commonly in use.

In Chapter X the design of motors is discussed in an equally intelligent manner. Chapters XI and XII are respectively devoted to dynamo and motor testing and efficiency tests, concluding with these the purely electrical part of the treatise. Two more chapters and four appendices devoted to correlative subjects, viz., steam engine calculations, tests on iron, ampere turntable, determination of sizes of wire and belting, complete this excellent little treatise.

In his definitions alone is the author open to censure. In these he seems to have been especially careless. As examples of this may be cited the definition of the unit of weight (p.9), which he gives "as the weight of a cubic centimeter of distilled water at 4° C.";—he should have added "weighed at Paris." The volt, which he defines as that electromotive force which will be generated in a conductor moving in a unit magnetic field with a velocity of 100,000,000 centimeters per second, apparently forgetting that a wire may be thus moved and generate any electromotive force between the limits of 1 and 0. The book was evidently in press before the late Electrical Congress, as the new unit of self-induction, the heury, is neither defined nor mentioned. With the above corrections and a few others the book is an entirely safe one to place in the hands of the student, and its extended adoption as a text book in schools is confidently predicted.

NELSON W. PERRY.

NEW BOOKS OF THE MONTH.

Bartlett, Wallace A.=A Digest of Trade Marks Registered in the United States. For machines, metals, jewelry, and the hardware and allied trades, with a synopsis of the law and practice relating to trade marks. Washington: Gibson Brothers. [8vo, 190 p., cloth, $2.50.]

Benson, W. A. S.=Elements of Handicraft and Design. New York: Macmillan & Co. [12mo, 151 p., $1.60.]

Bent, B. J. Theodore.=The Ruined Cities of Mashonaland. Being a record of excavation and exploration in 1891, with a chapter on the orientation and mensuration of the temples, by R. M. W. Swan. New York: Longmans, Green & Co. [8vo, 328 p., ill., cloth, $2.50.]

Brooks, Francis A.=Objections Legal and Practical to Our National Currency System, Boston: G. B. Reed. [8vo, 56 p., pap., 25 cents.]

Bose, T.=Practical Treatise on the Strength of Materials, including their Elasticity and Resistance to Impact. New York: Spon & Chamberlain. [8vo, 525 p., cloth, $7.25.]

Burn, R. S.=The Illustrated Architectural Engineering and Mechanical Drawing-Book, for the Use of Students and Artisans. Corrected edition, with new matter. New York: Ward, Lock & Bowden. [8vo, 155 p., cloth, 75 cents.]

Cooke, C. J. Bowen.=British Locomotives, Their history, construction and modern development. New York: Macmillan & Co. [12mo, 381 p., cloth, $2.]

Drake, S. Adams.=Our Colonial Homes. Boston: Lee & Shepard. [8vo, 215 p., ill., cloth, $2.50.]

Hazlitt, W. Carew=The Coinage of the European Continent. With an introduction and catalogues of mints, denominations, and rulers. New York: Macmillan & Co. [8vo, 570 p., cloth, $5.]

Haeder, Herman.=Handbook on the Steam-Engine. With special reference to small and medium-sized engines, for the use of engine-makers, mechanical draughtsmen, and users of

steam power. From the German by H. P. Powles. New York: D. Van Nostrand Co. [12mo, 446 p., cloth, $3.]

Hubert, Philip G., Jr.=Inventors. New York: C. Scribner's Sons. [8vo, 300 p., $2.]

Jackson, Dugald C.=Text-Book on Electro-Magnetism and the Construction of Dynamos. V. 1. New York: Macmillan & Co. [12mo, 281 p., cloth, $2.25.]

Johnson, Emory R.=Inland Waterways. Their Relation to Transportation. Philadelphia: American Academy of Political and Social Science. [8vo, 166 p., paper $1.]

Loewinson-Lessing, F. *compiler.*=Tables for the Determination of the Rock-Forming Minerals. From the Russian, by J. W. Gregory; with a chapter on the petrological microscope by G. A. J. Cole. New York: Macmillan & Co. [8vo, 55 p., cloth, $1.]

Love, A. E. H.=Treatise on the Mathematical Theory of Elasticity, v. 2. New York: Macmillan & Co. [8vo, 327 p., cloth, $3.]

Lewis, G. H.=National Consolidation of the Railways of the United States. New York: Dodd, Mead & Co. [12mo, 342 p., cloth, $1.50.]

Macleod, H. Dunning.=Theory and Practice of Banking. New York: Longmans, Green & Co. [8vo, 240 p., cloth, $5.]

Mayet, P.=Agricultural Insurance. In organic connection with savings banks, land credit, and the commutation of debts. From the German, by Rev. Arthur Lloyd. New York: Macmillan & Co. [8vo, 288 p., cloth, $3 50.]

McKinney, W. M. *editor.*=American and English Railroad Cases. A collection of all the railroad cases in the courts of last resort in America and England. Northport, N. Y.: E. Thompson Co. [8vo, 68 p, shp., $4.50.]

Morris, W.=Arts and Crafts. Essays by members of the Arts and Crafts Exhibition Society. New York: C. Scribner's Sons. [8vo, cloth, $2.50.]

Preece, W. H.=A Manual of Telephony. New York: Macmillan & Co. [12mo, cloth, $4.50.]

Ruskin, J.=The Elements of Drawing. In three letters to beginners. New York: Maynard, Merrill & Co. [12mo, 417 p., cloth, $1.50.]

Salomons, Sir D.=Electric Light Installations. Vol. 1. The management of accumulators: a practical hand book. New York: D. Van Nostrand Co. [12mo, 170 p., cloth, $1.50.]

Spalding, F. P.=Note on the Testing and Use of Hydraulic Cement. Ithaca, N. Y.: Andrews & Church. [16mo, 1113 p., cloth, $1.]

Smeaton, J.=Plumbing and Drainage, Water Supply and Hot-Water Fitting. New York: Spon & Chamberlain. [8vo, cloth, 236 p., $3.]

Taylor, D. W.=The Resistance of Ships and Screw Propulsion. New York: Macmillan & Co. [8vo, cloth, $3.75.]

Todhunter, I.=History of the Theory of Elasticity and of the Strength of Materials from Galilei to the Present Time. Edited by K. Pearson. V. 2 Pts. 1 and 2. New York: Macmillan & Co. [8vo, cloth, $7.50.]

United States, State Department.=Bureau of American Republics. Bulletin No. 55. Bolivia. Mines, trade routes, patents, population, etc. Washington: Government Printing Office. [8vo, 420 p.]

Ziwet, Alex.=An Elementary Treatise on Theoretical Mechanics. Pt. 1.—Kinematics. New York: Macmillan & Co. [8vo, 181 p., cloth, $2.25.]

Campbell, Helen.=Women Wage-Earners; Their Past, Present, and Future, with an introduction by R. T. Ely. Boston: Roberts Brothers. [12mo, 318 p., cloth, $1.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Field Engineering Company, New York.=Vertical Multi-Cylinder Engines for Electric Service. 30 p. [Illustration and description of engines capable of carrying loads continuously under extreme conditions and showing the highest economy for that service, whether lighting, railway, or power.]

Industrial Works, Bay City, Mich.=Cranes and Special Railway Appliances. 107 p. [I.—Cranes for railroad uses. II.—Steam excavators, railroad pile driver, transfer tables, portable steel rail saw.]

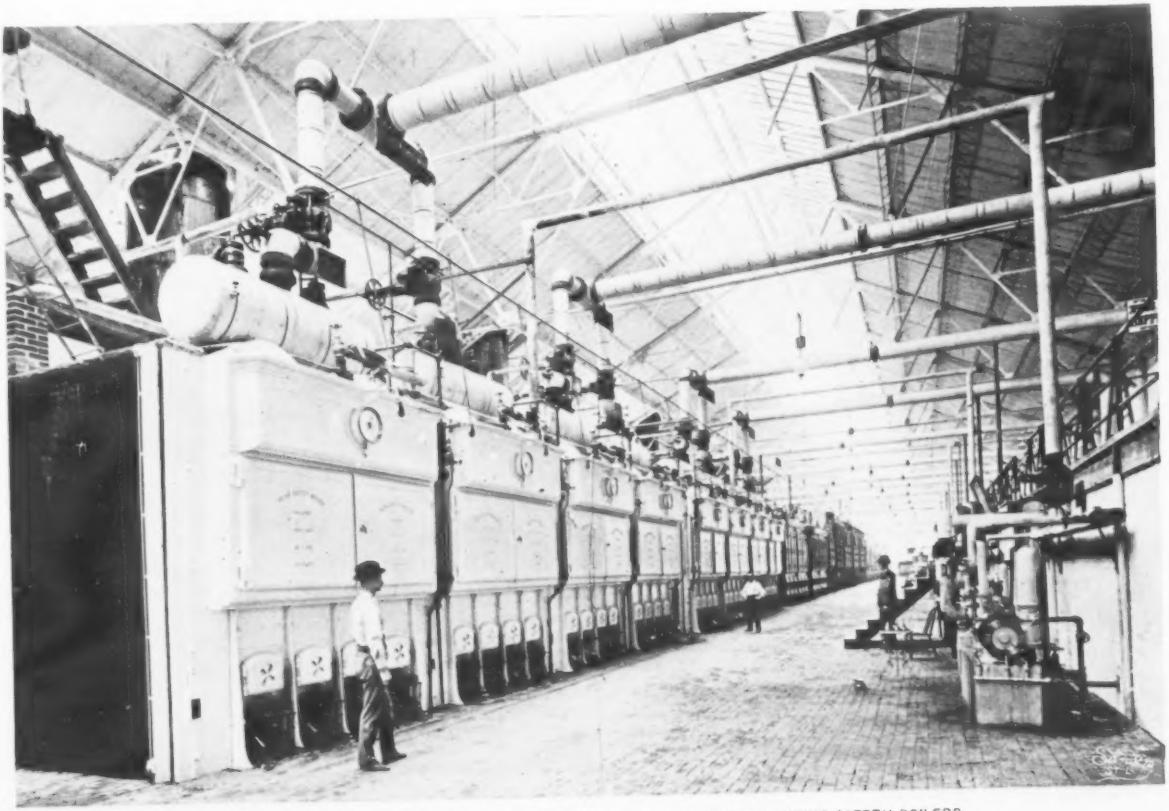
Builders' Iron Foundry, Providence, R. I.=The Venturi Meter. [Named after the Italian philosopher who first called attention to the relation between the movement and pressures of fluids when flowing through converging and diverging tubes, and consists of two parts, the tube, through which the water flows, and the recorder, which registers the quantity of water that passes through the tube.]

Alonzo C. Mather, Chicago.=The Practical Thoughts of a Business man. 88 p. [Successful enterprises organized by and on patents granted to the author, the author's undeveloped patents and possibilities; with chapters on such general subjects as unrestricted trade between Canada and the United States, proposed New York and Chicago electric system of transportation, three-rail tracks, etc.]

The Cincinnati Milling Machine Co., Cincinnati.=New Universal Cutter and Tool Grinder. 24 p. [Differs from other machines in the fact that it will grind any cutter and reamer without the use of special attachments, and that all work is done on a horizontal slide; also arranged for grinding cylindrical, conical, and flat surfaces.]

John P. Lovell Arms Co., Boston.=Lovell Diamond Cycles. 48 p. [Illustrating and describing the New Roadster, Light Roadster, New Ladies' Wheel, and the bicycles speed, strength and grace claimed.]

The Edward P. Allis Company, Milwaukee.=Reynolds' Quadruple Expansion Engine. 14 p. [The representative engine of the Exposition, more than twice as powerful as the Centennial Corliss engine. Maximum capacity from 3000 to 4000 H.-P.]



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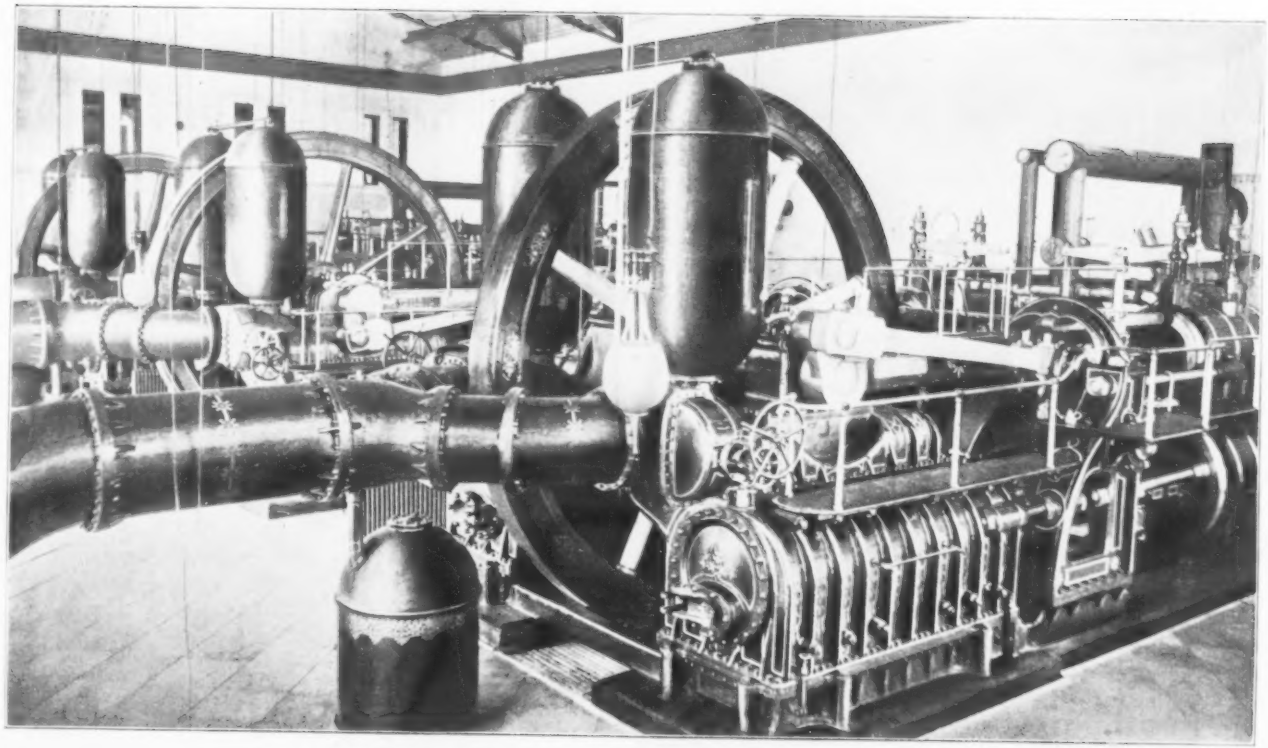

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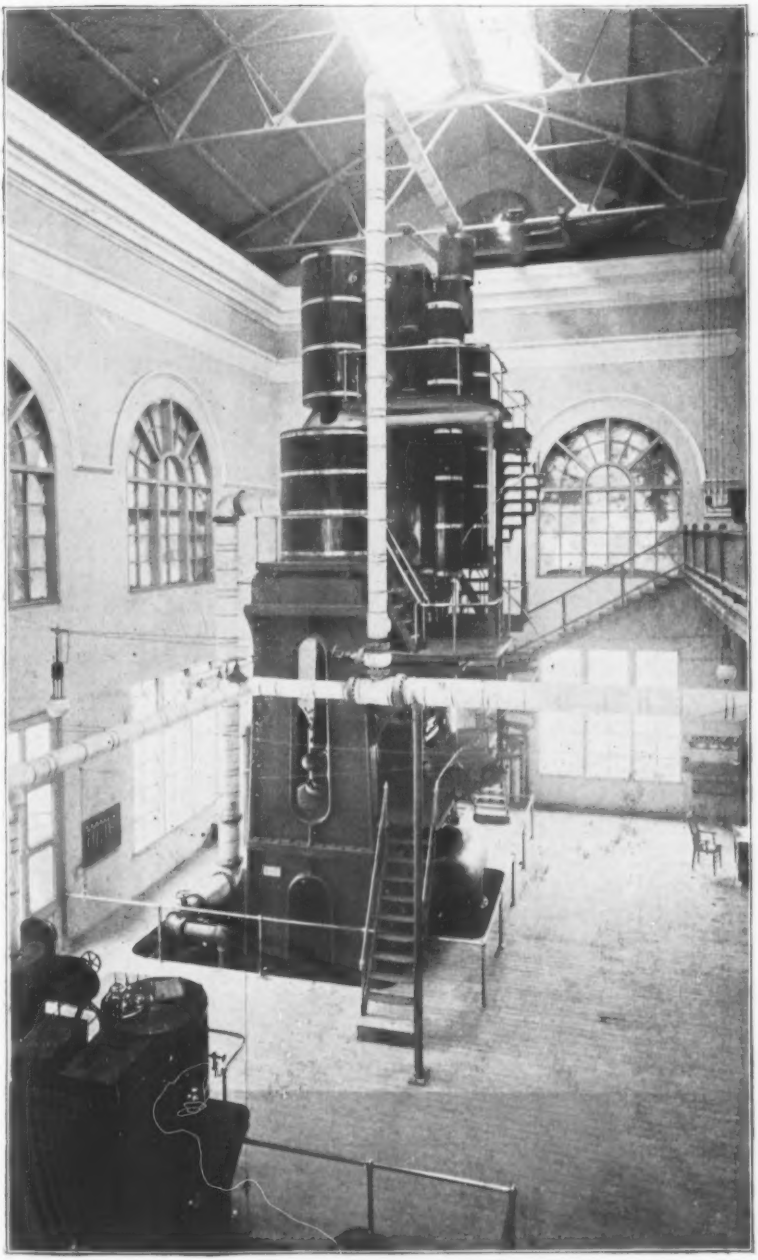

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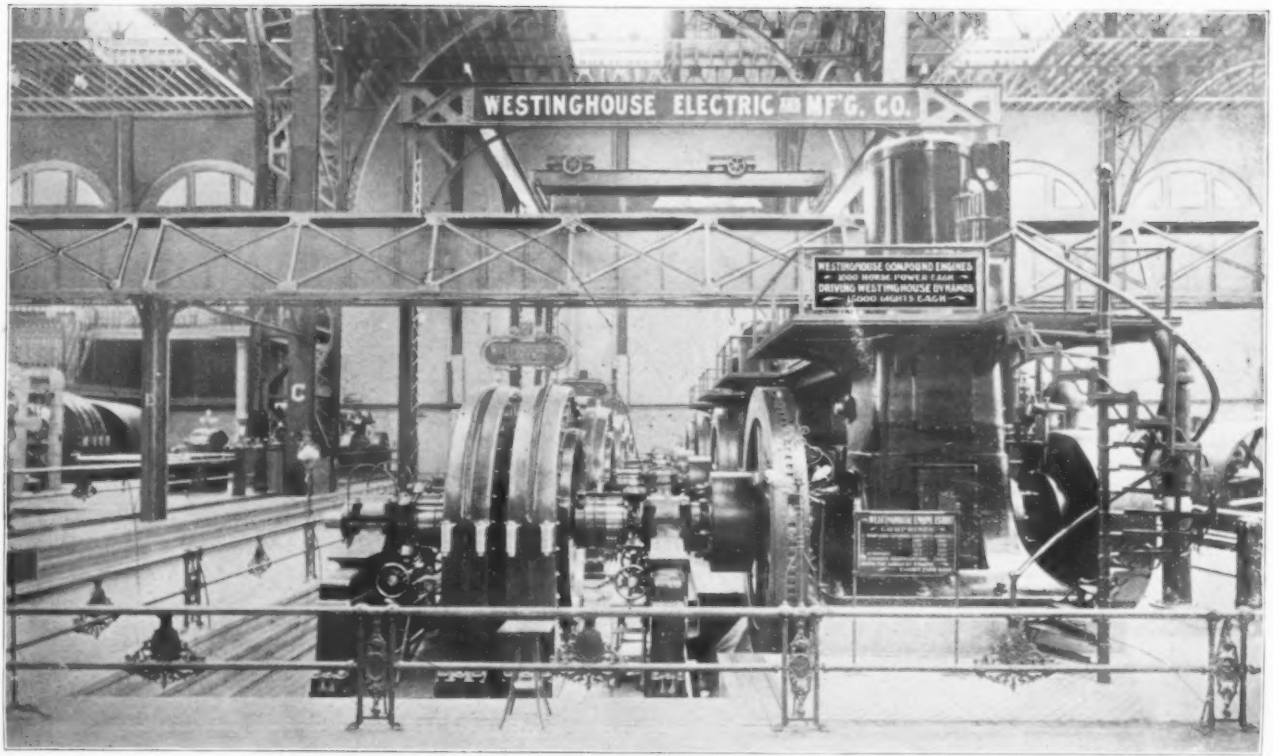

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Shewing an end view of the four 2000 H. P. Westinghouse Compound Engines connected with the 12000 light Westinghouse Dynamos.

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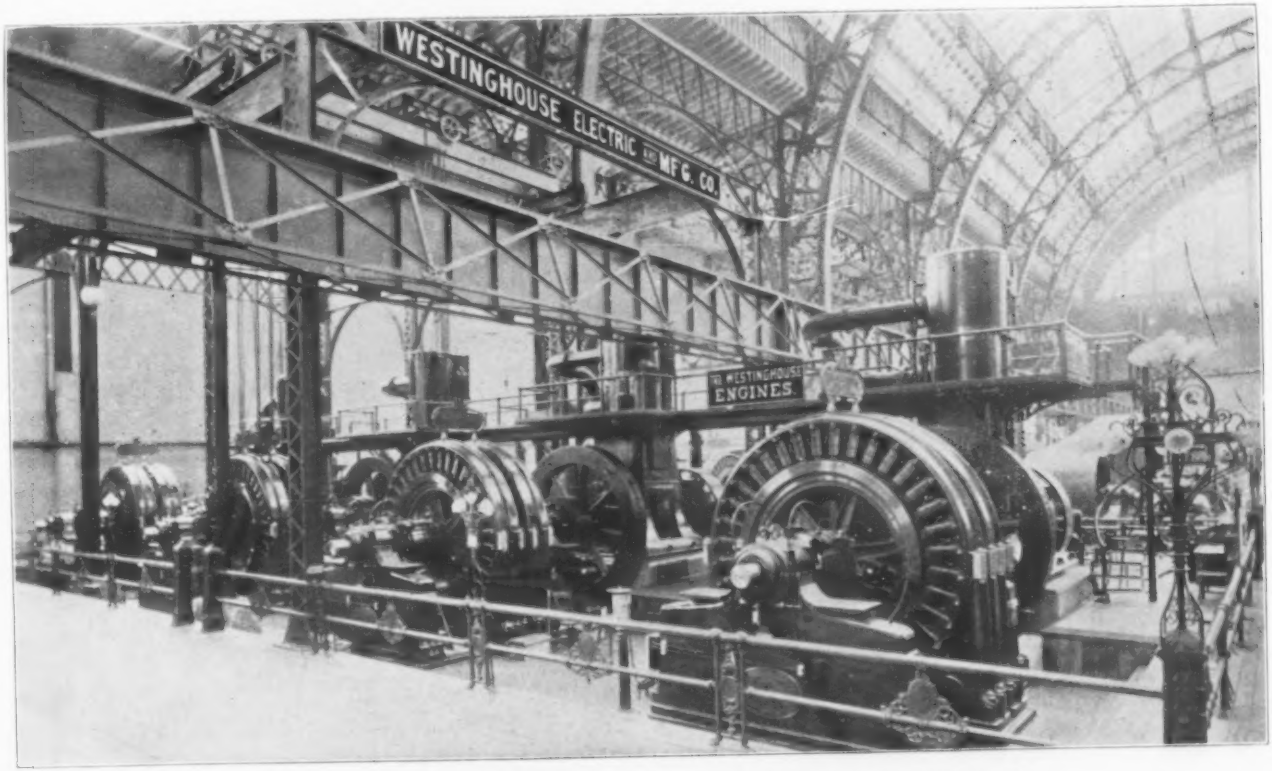
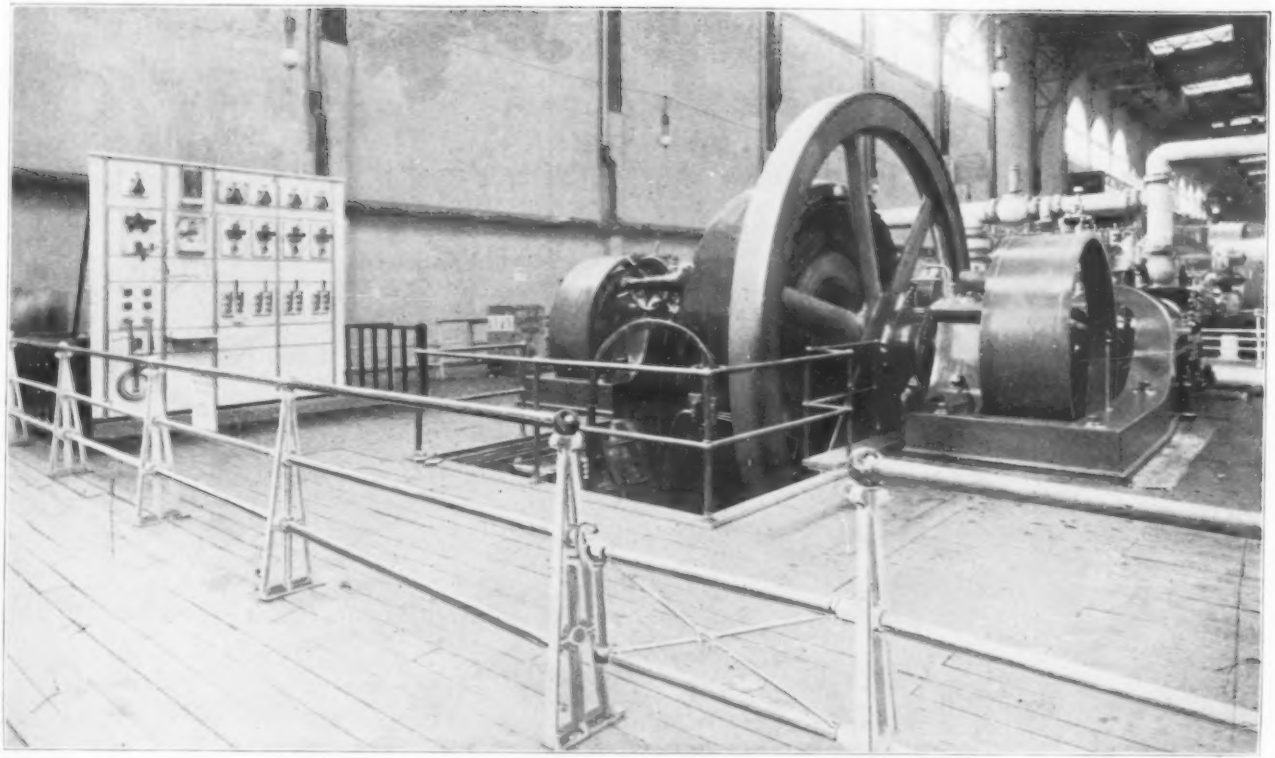


ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.
Side view of the four 15,000 light Westinghouse Dynamos, with the 1000 H. P. Westinghouse Engines in the background.



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End view of the 750 H. P. 500 volt Power Generator. Connected direct to the Cross Compound Allis Engine; Switchboard for the Generator to the left.

ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.

End view of the 2500 H. P. 500 volt Power Generator. Connected direct to the Cross Compound Allis Engine; Switchboard for the Generator to the left.

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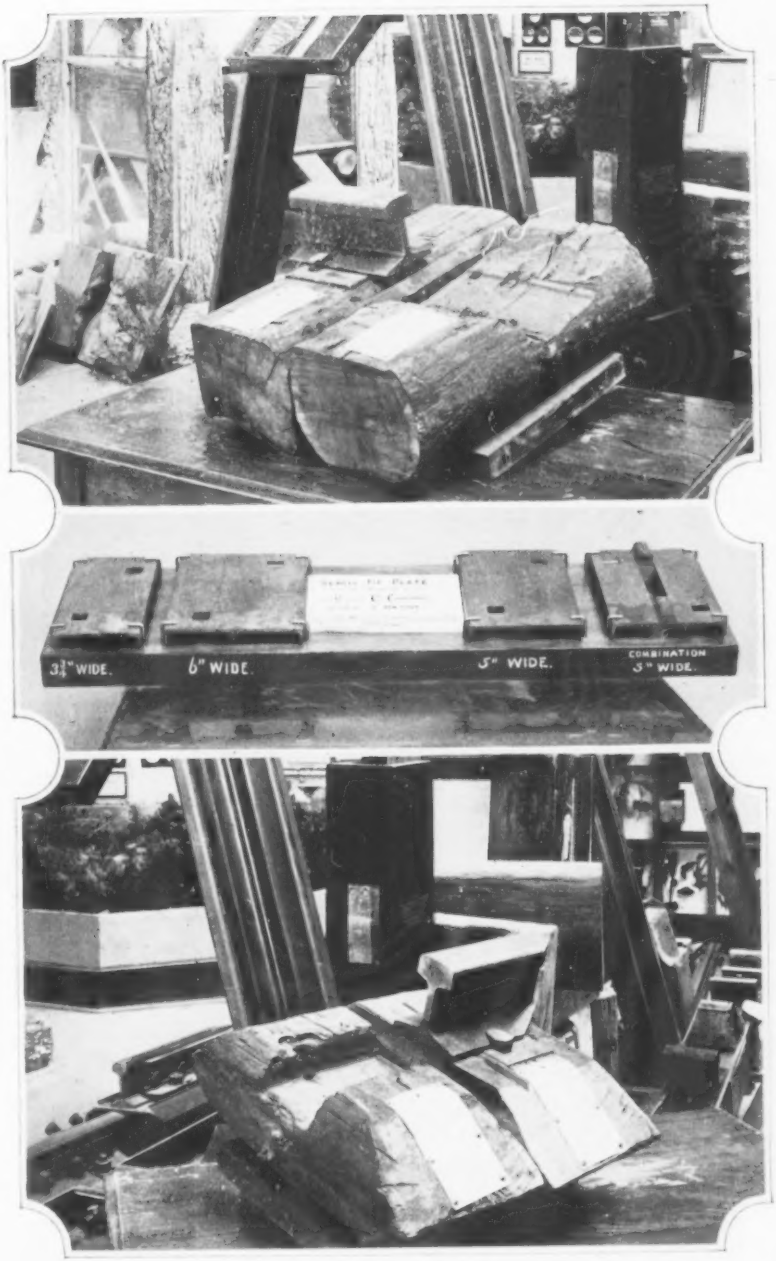
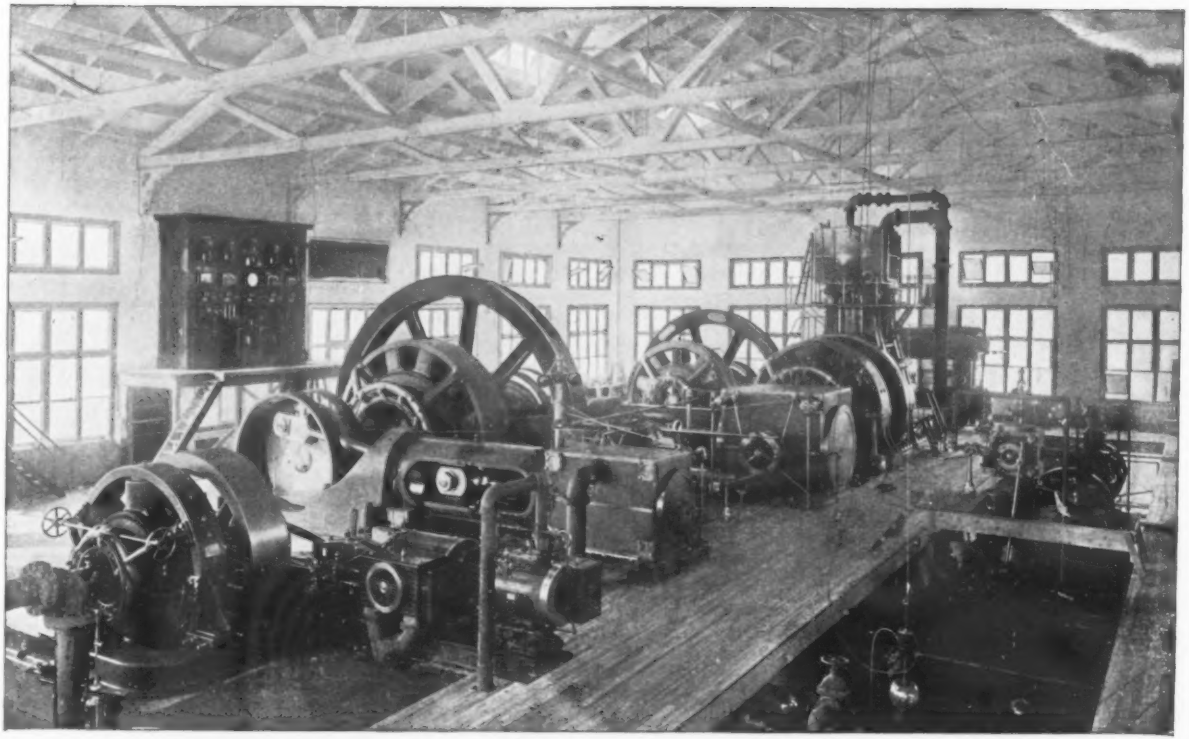
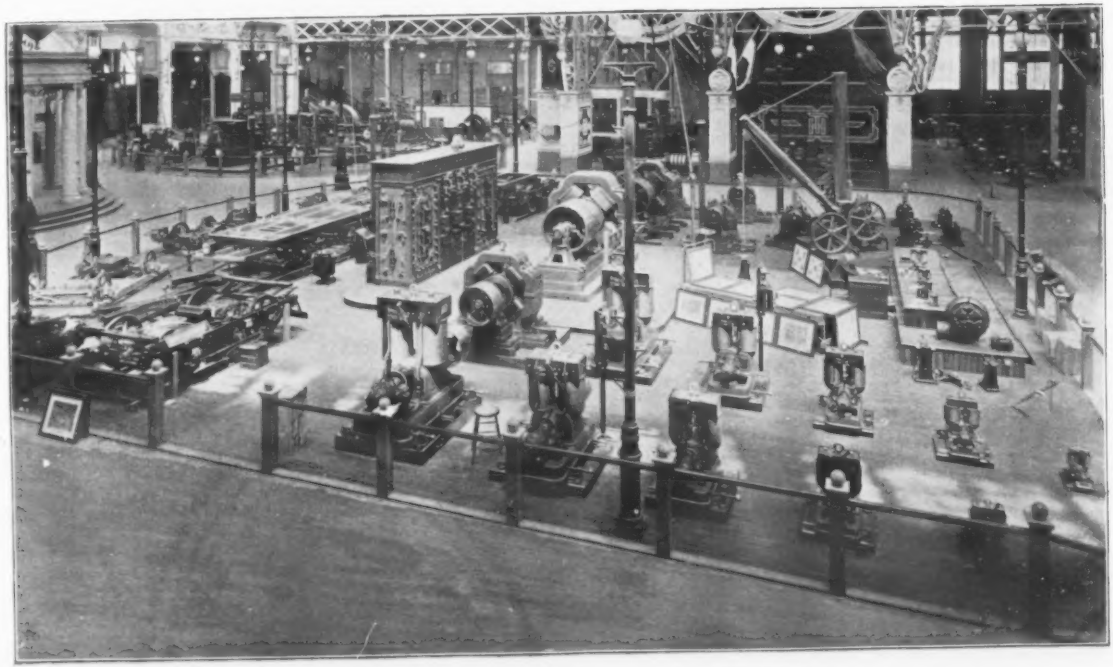


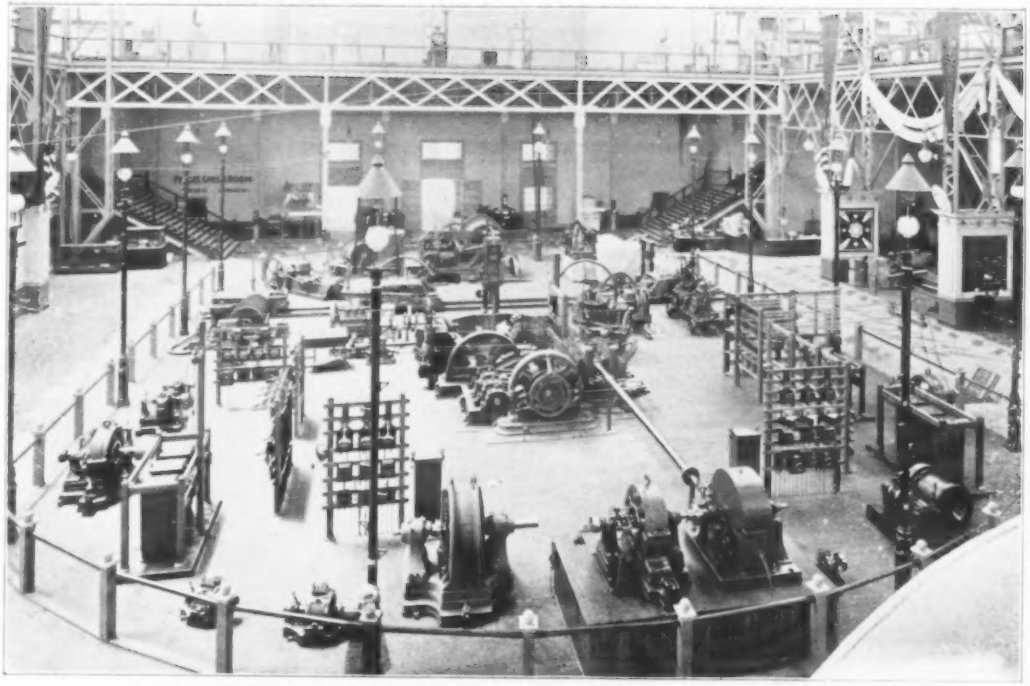
U. S GOVERNMENT EXHIBIT—FORESTRY DIVISION, AGRICULTURAL DEPARTMENT.
Illustrating the preservation of railroad ties by the use of the Q. & C. Company's Servis Tie Plate.



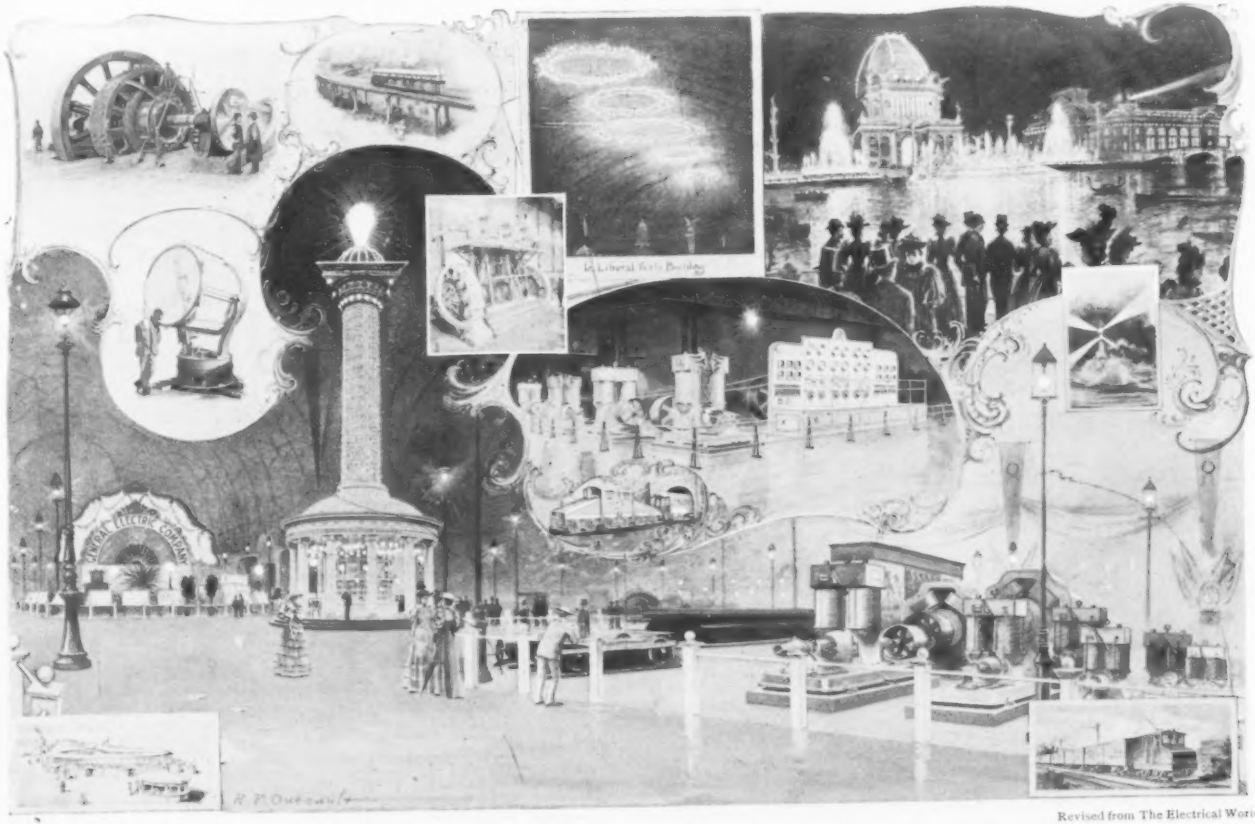
THE GENERAL ELECTRIC COMPANY—INTERIOR OF THE INTRAMURAL RAILWAY POWER-HOUSE.
The Largest Single Exhibit of Moving Machinery at the Fair.



ELECTRICITY BUILDING—RAILWAY AND MOTOR EXHIBIT OF THE GENERAL ELECTRIC CO.



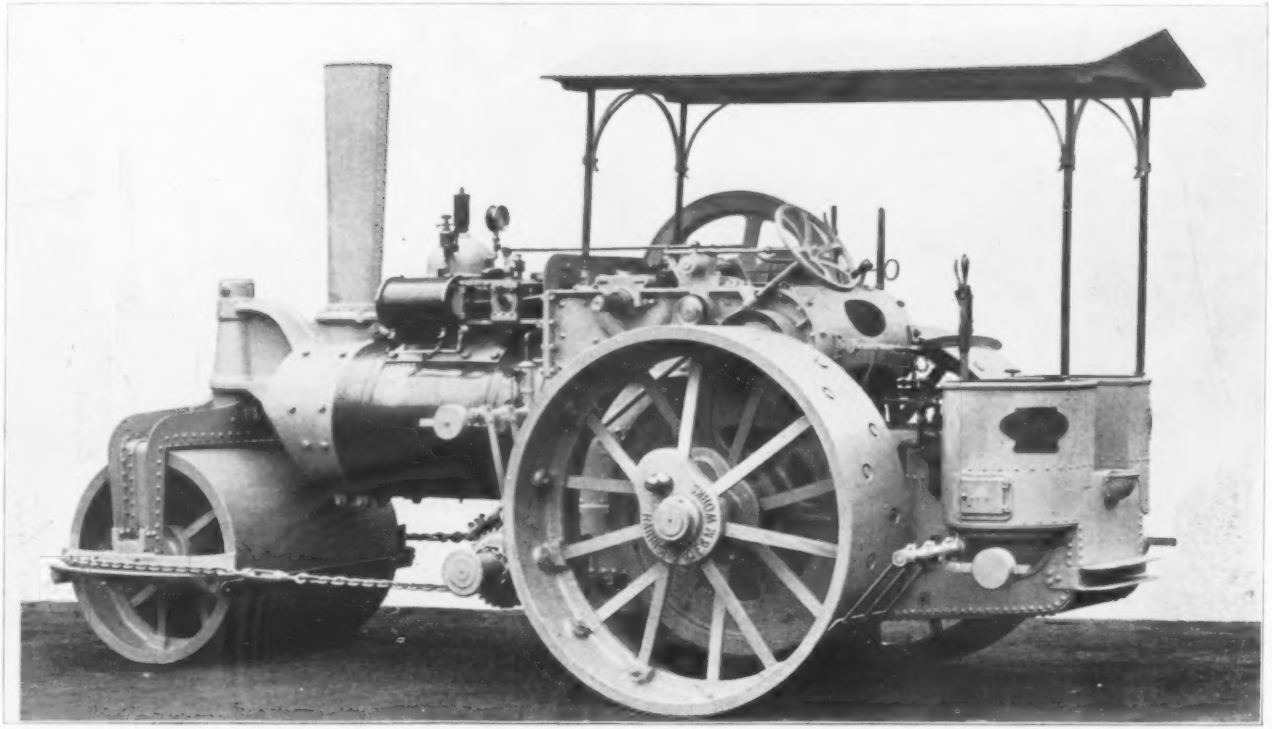
ELECTRICITY BUILDING—MINING EXHIBIT OF GENERAL ELECTRIC COMPANY.
Model Three-Phase Power-Transmission Plant in the foreground.



Revised from The Electrical World.

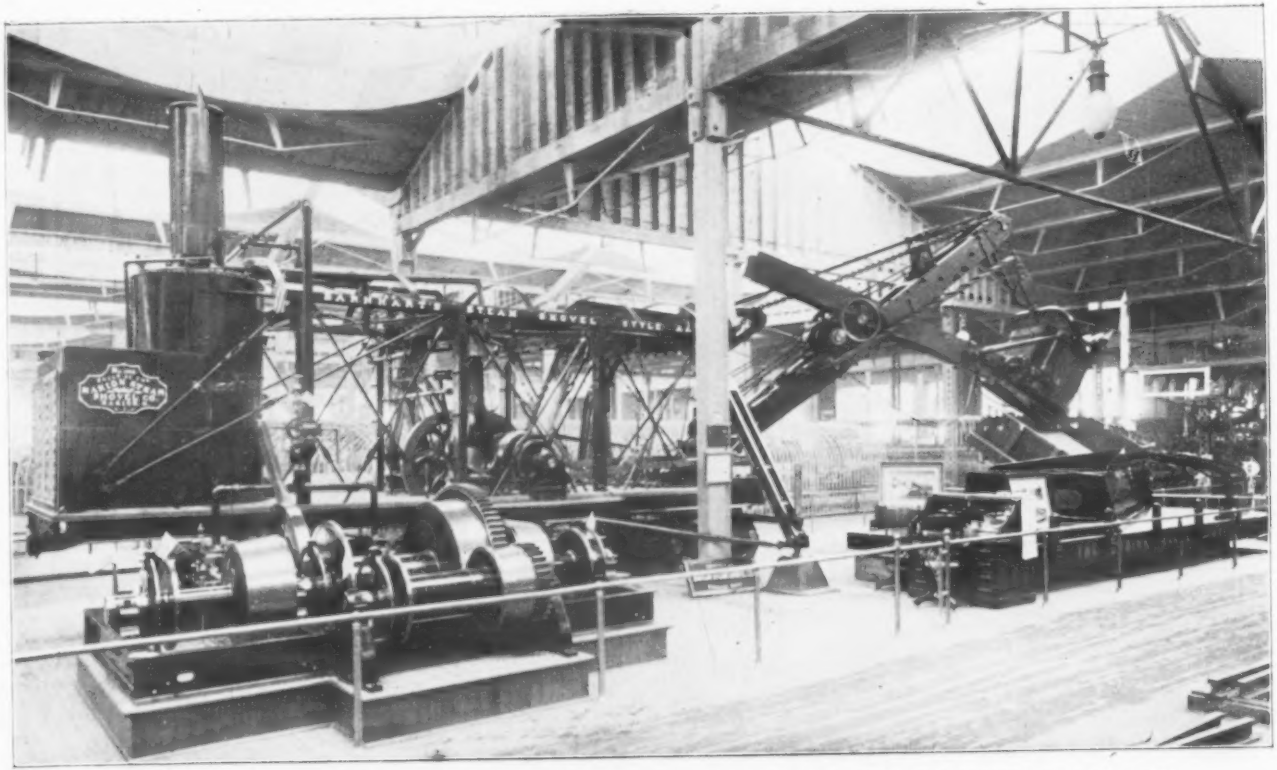
ELECTRICITY BUILDING—LEADING FEATURES OF THE GENERAL ELECTRIC COMPANY'S EXHIBITS.

2000 H. P. Railway Generator.
Largest Search-Light in the World.
Movable Sidewalk.
Intramural Railway.
The Great Generator.
Tower of Light.
Service Plant, Machinery Hall.
90 Ton Locomotive.
Railway Exhibit.
Electric Fountains.
Battle-Ship.
30 Ton Locomotive.

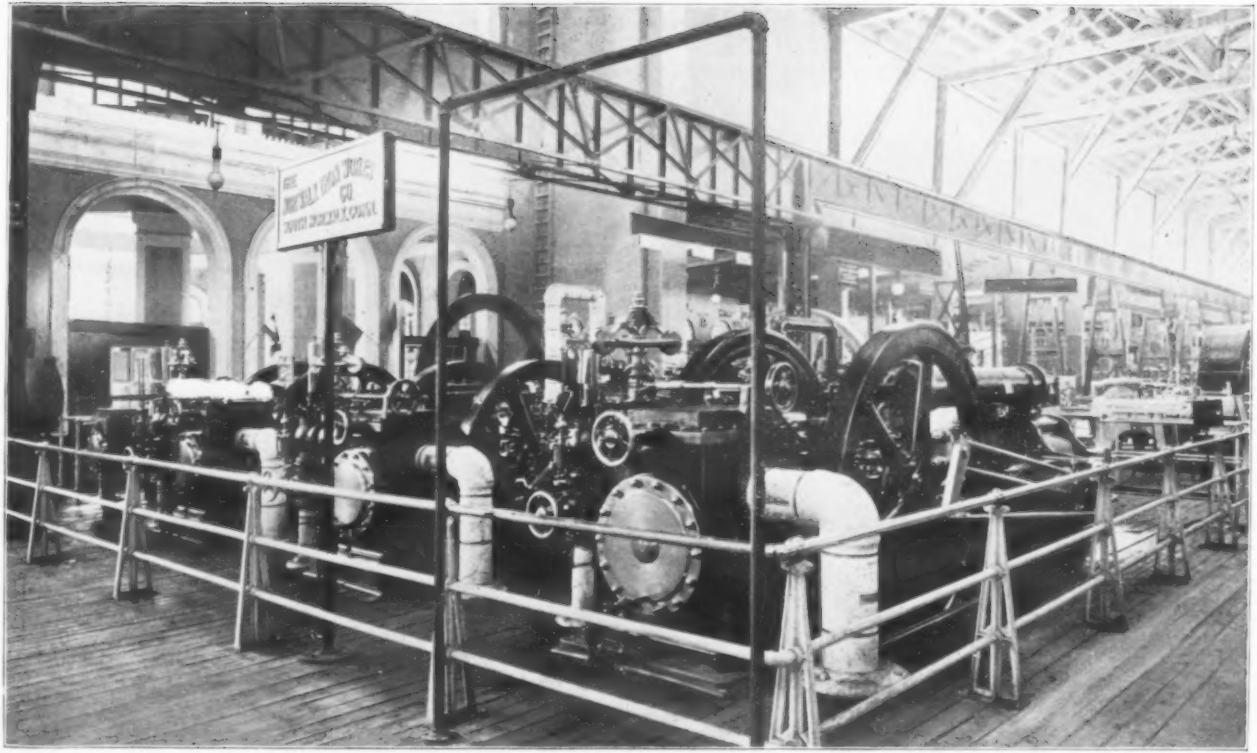


THE HARRISBURG STEAM ROAD ROLLER—HARRISBURG FOUNDRY & MACHINE WORKS, HARRISBURG, PA.

Actively employed for 18 months in making the road-ways of the Fair grounds.



TRANSPORTATION BUILDING—EXHIBIT OF THE MARION STEAM SHOVEL CO., MARION, OHIO—STEAM SHOVELS, DREDGES, EXCAVATORS, ETC.



TRANSPORTATION BUILDING—EXHIBIT OF THE NORWALK IRON WORKS CO., SO. NORWALK, CONN.
Showing four Norwalk Air Compressors, actively employed night and day for nearly 18 months for building and exhibition purposes.

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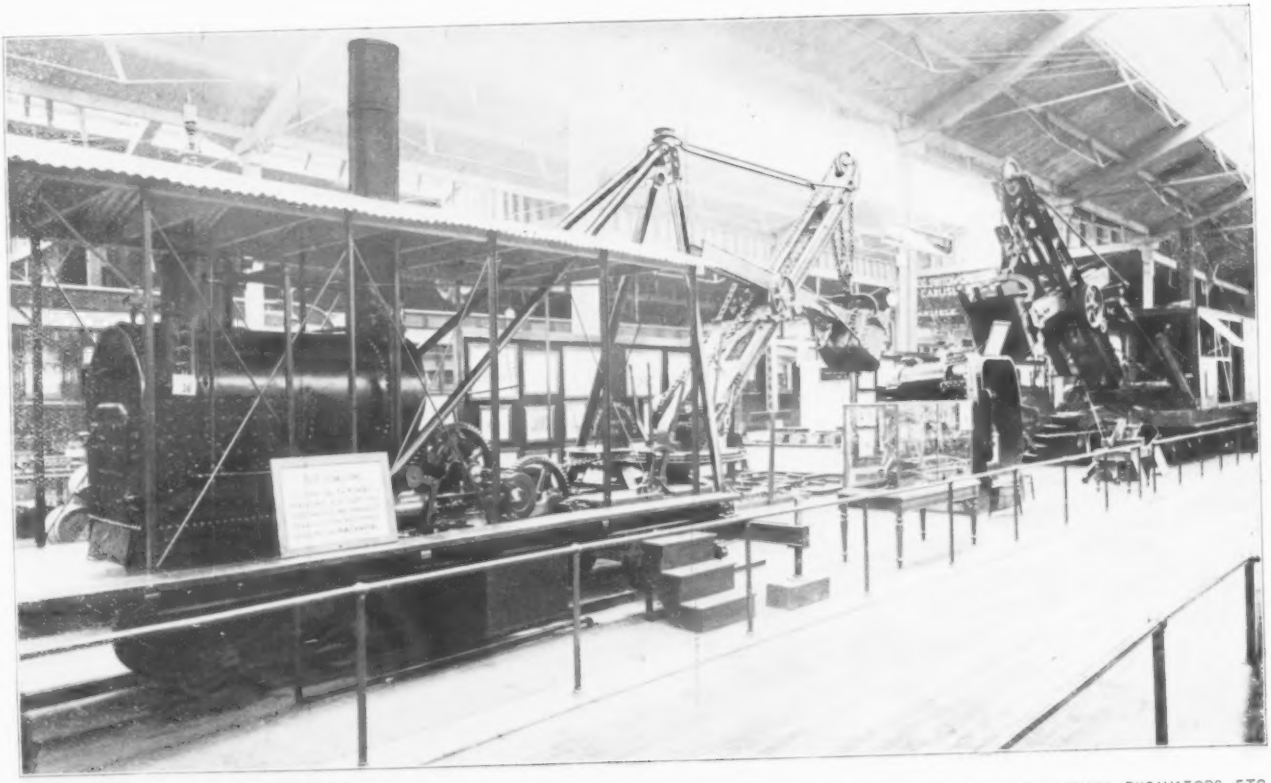
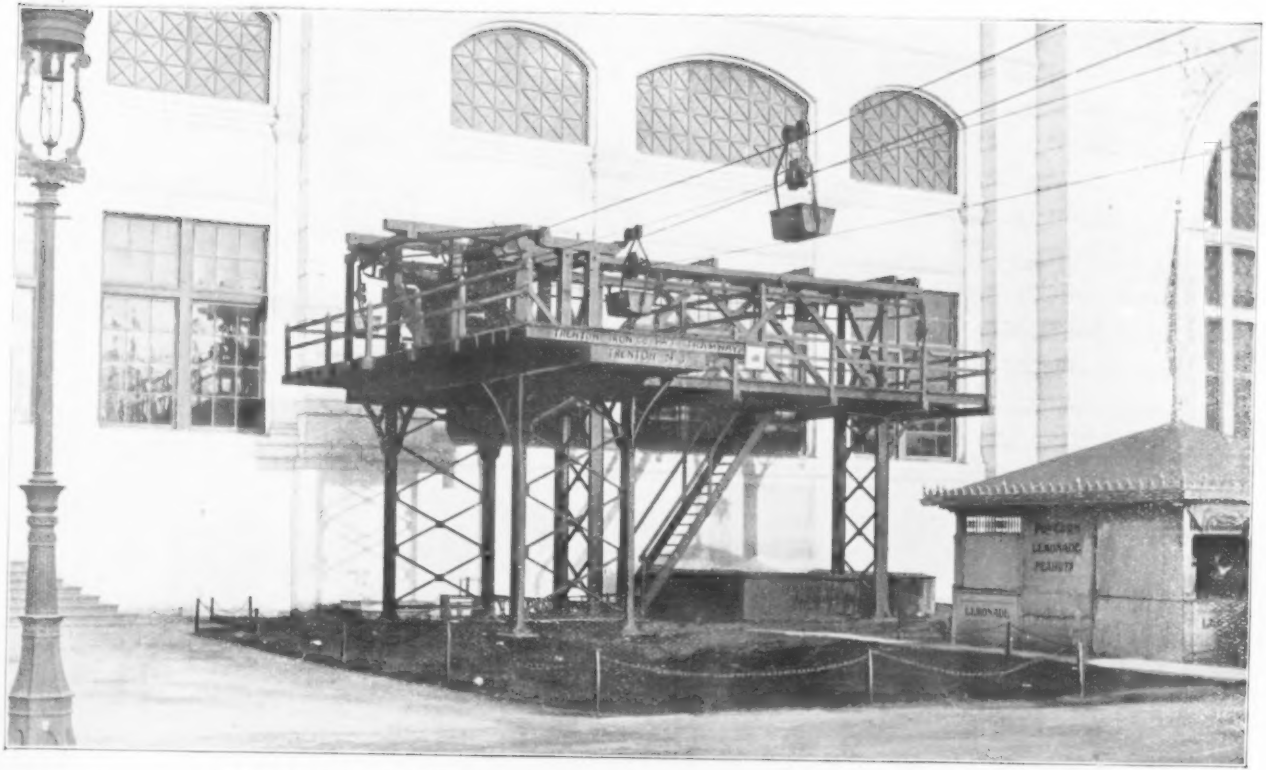
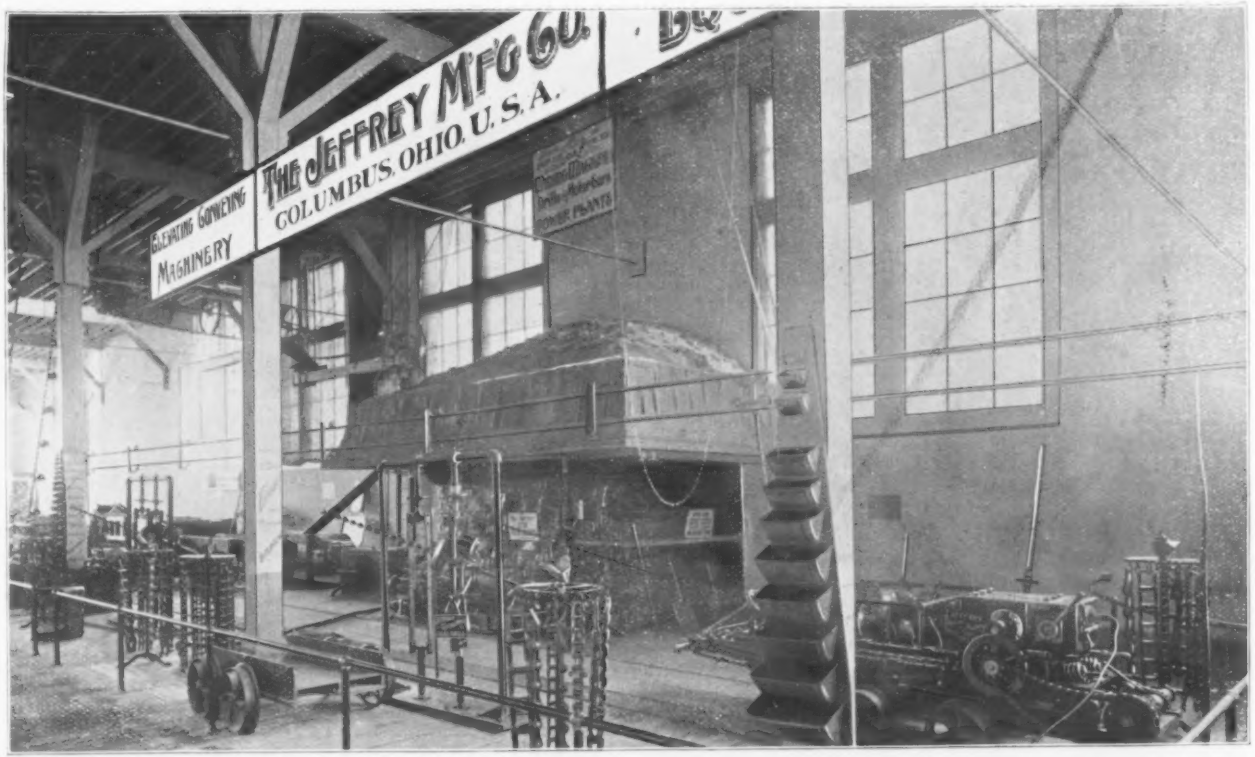


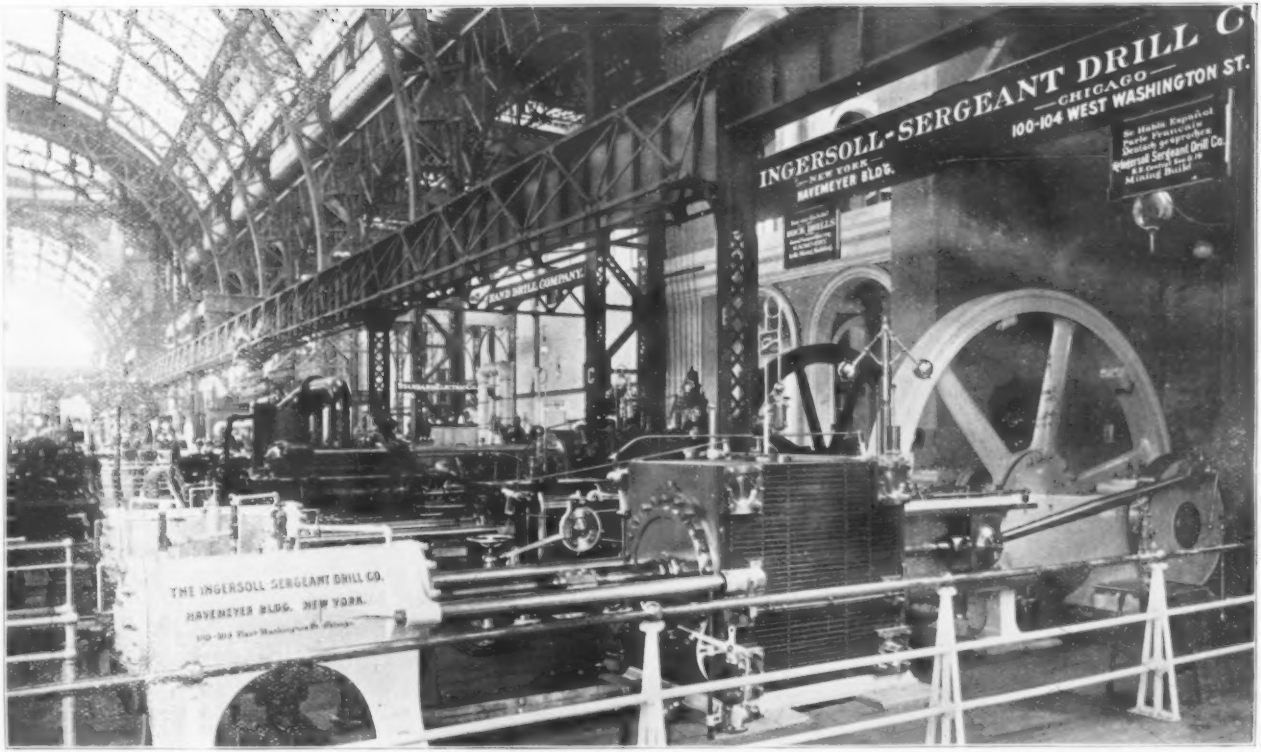
TRANSPORTATION BUILDING—EXHIBIT OF THE BUCYRUS STEAM SHOVEL & DREDGE CO., SOUTH MILWAUKEE, WIS.—STEAM SHOVELS, DREDGES, EXCAVATORS, ETC.



THE BLEICHERT IMPROVED WIRE ROPE TRAMWAY—EXHIBITED BY THE TRENTON IRON CO., TRENTON, N. J.

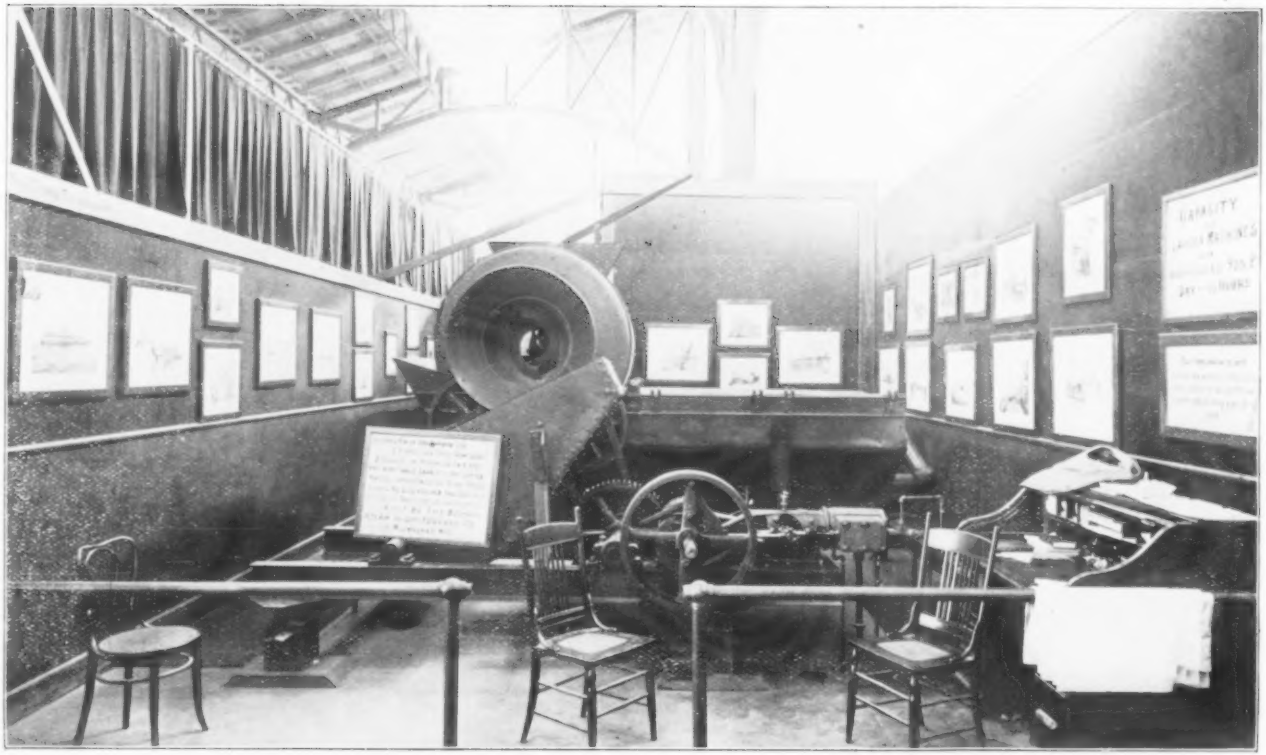


MINES AND MINING BUILDING.—EXHIBIT OF THE JEFFREY M'F'G CO., COLUMBUS, OHIO.—CONVEYING MACHINERY, ELECTRIC COAL CUTTERS, AND MINING MACHINERY.

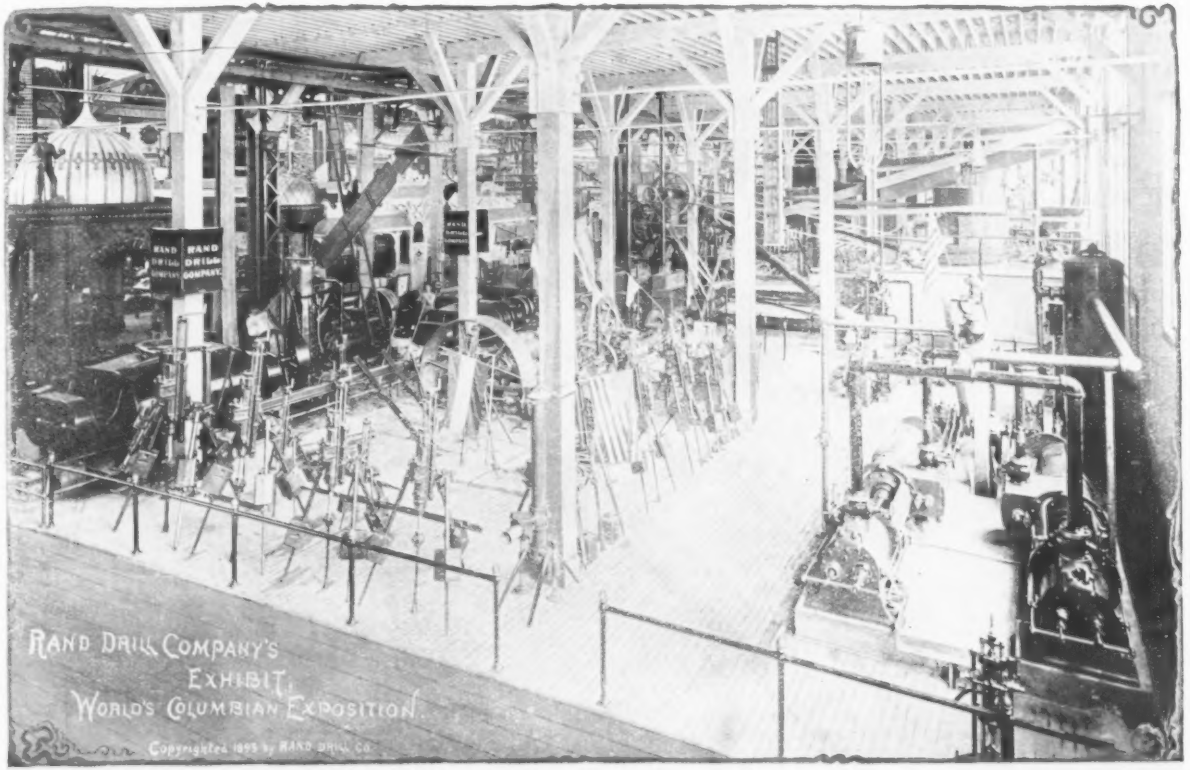


MINES AND MINING BUILDING—EXHIBIT OF THE INGERSOLL-SERGEANT DRILL CO.—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

MINES AND MINING BUILDING—EXHIBIT OF THE WEBSTER, CAMP & LANE MACHINE CO.—CORLISS ENGINES, HOISTING ENGINES, AND GENERAL MINING MACHINERY.



MINES AND MINING BUILDING—EXHIBIT OF THE BUCYRUS STEAM SHOVEL AND DREDGE CO., SOUTH MILWAUKEE, WIS.—PLACER AMALGAMATORS.

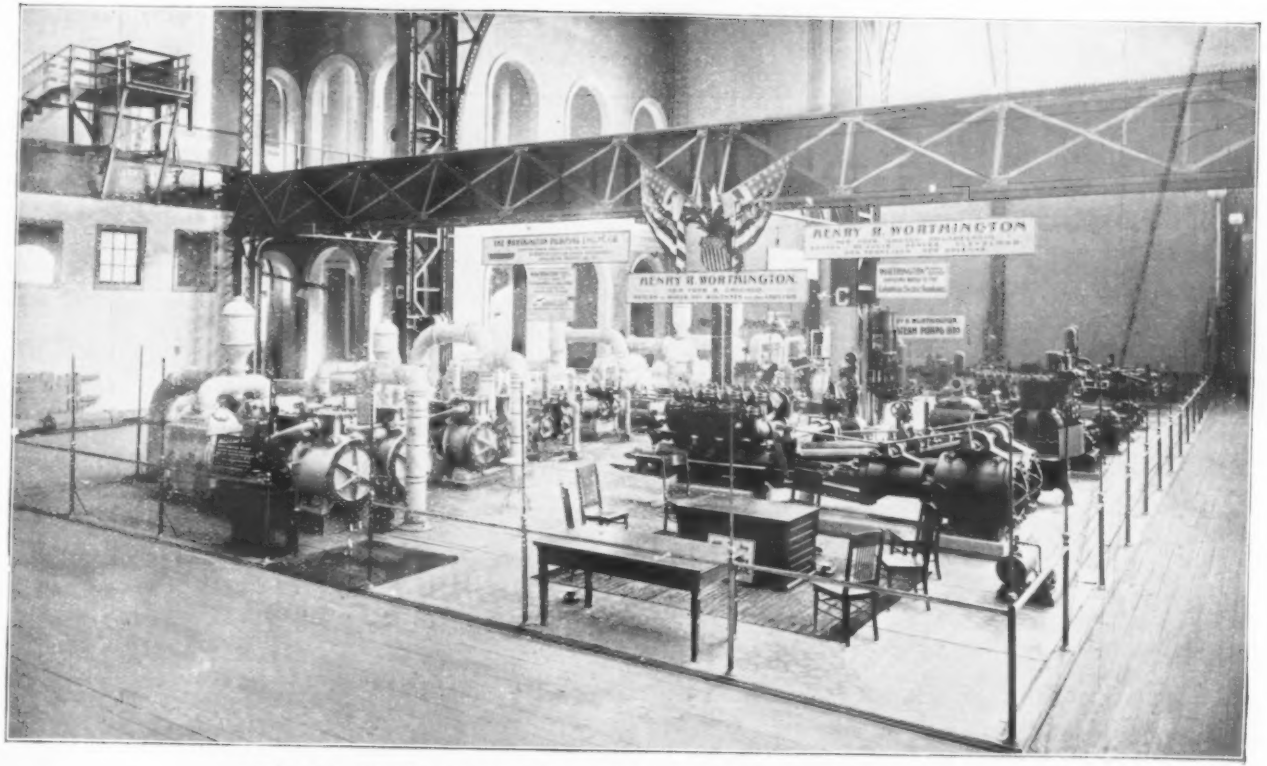


MINES AND MINING BUILDING—EXHIBIT OF THE RAND DRILL CO., NEW YORK—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

WILLIAM JESSOP & SONS LTD SHEFFIELD ENGLAND
CIRCULAR SAW PLATE 84" DIAMETER
ESTABLISHED, 1793
CIRCULAR SAW PLATE 72" DIAMETER
CAESAR, ADAMS & CO.
PRINCIPAL AMERICAN OFFICE 91 JOHN STREET, NEW YORK
W. JESSOP & SONS

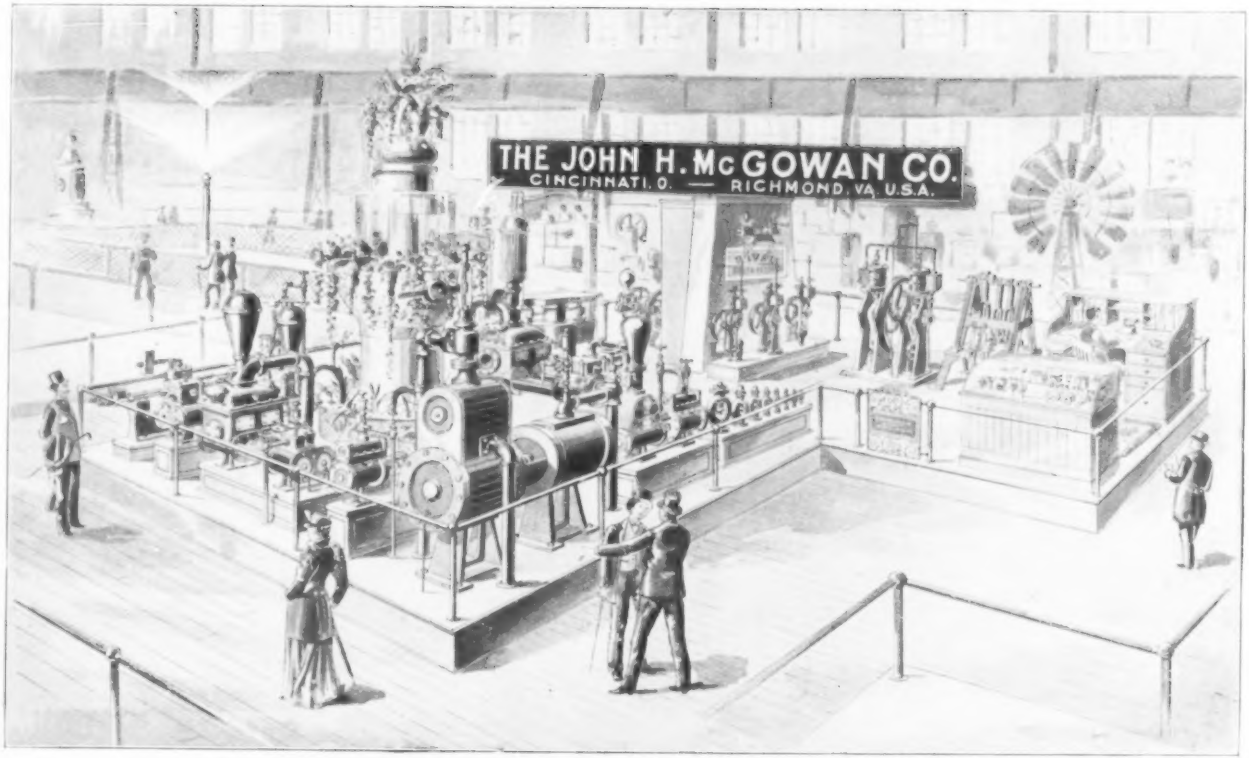
MINES AND MINING BUILDING—EXHIBIT OF WILLIAM JESSOP & SONS, LTD., SHEFFIELD AND NEW YORK—STEEL MANUFACTURERS.
(This entire exhibit was presented by the firm to the Chicago Columbian Museum.)

MACHINERY HALL.—EXHIBIT OF THE STILLWELL-BIERCE AND SMITH-VAILE CO., DAYTON, OHIO.—STEAM PUMPS, TURBINE WATER WHEELS, FEED-WATER HEATERS ETC.

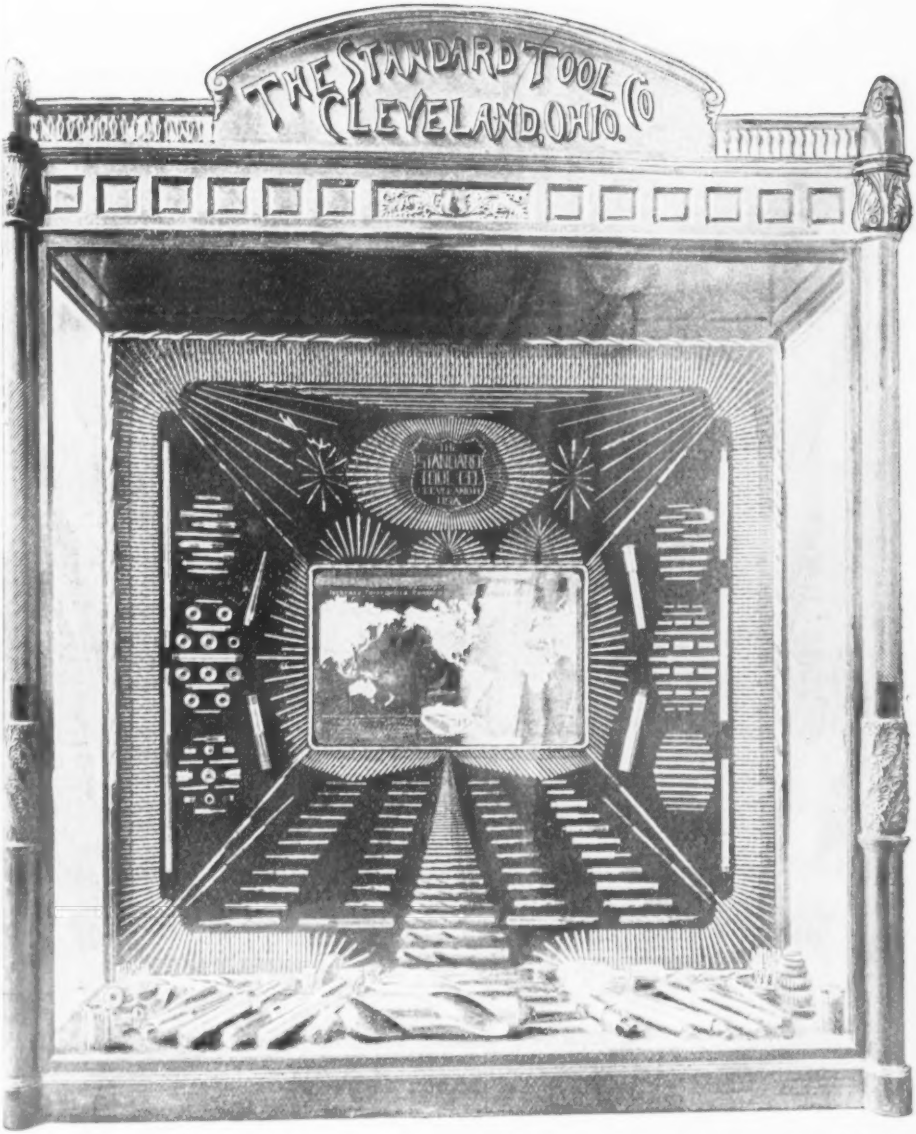


MACHINERY HALL.—THE HENRY R. WORTHINGTON EXHIBIT OF PUMPING MACHINERY.

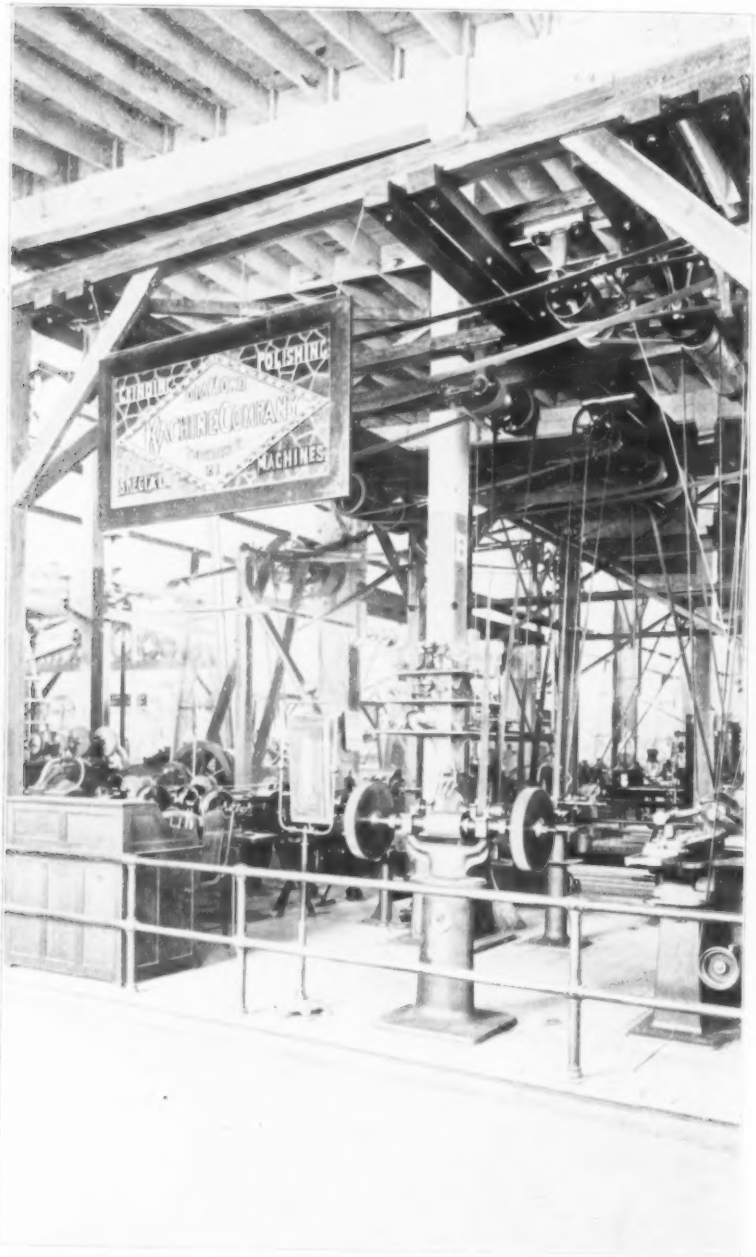
MACHINERY HALL.—EXHIBIT OF THE STILES & PARKER PRESS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.



MACHINERY HALL.—EXHIBIT OF THE JOHN H. McGOWAN CO., CINCINNATI, OHIO.—PUMP MANUFACTURERS.



MACHINERY HALL.—A PORTION OF THE EXHIBIT OF THE STANDARD TOOL CO., CLEVELAND, OHIO.—METAL WORKING TOOLS.

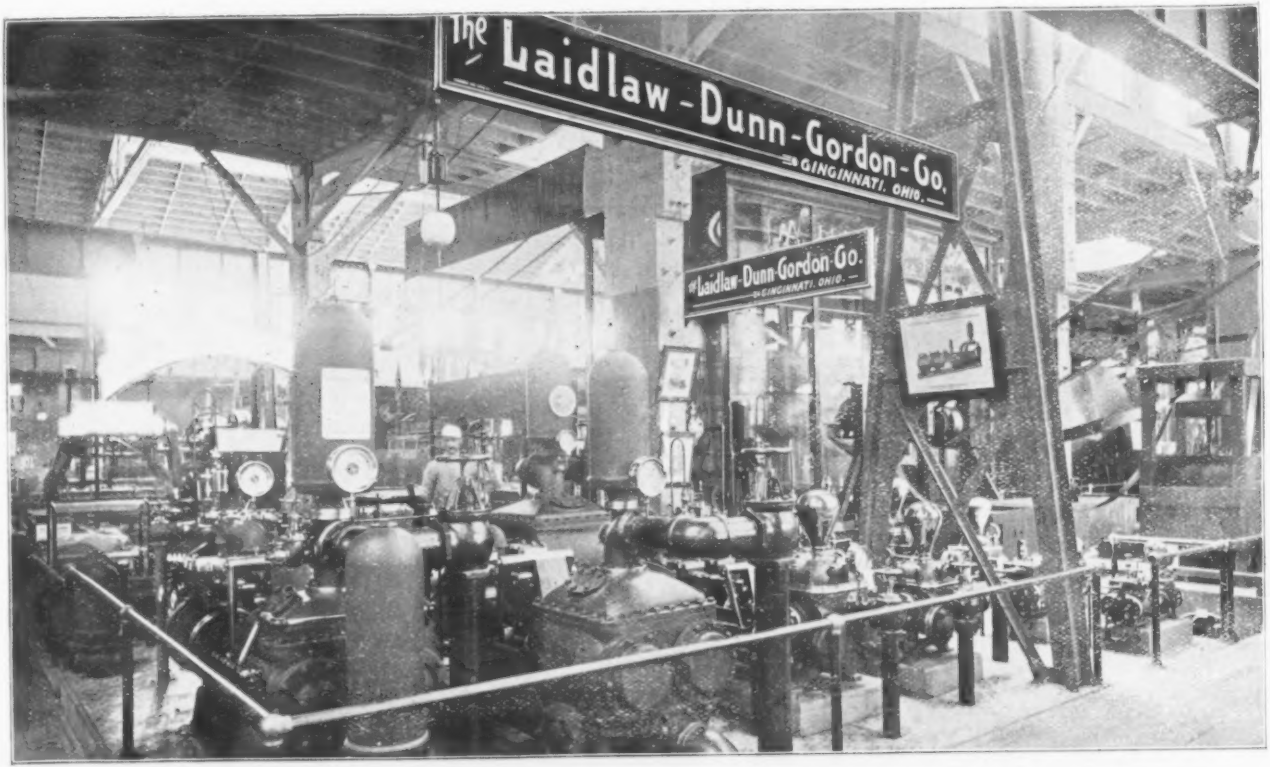


MACHINERY HALL—EXHIBIT OF THE DIAMOND MACHINE CO., PROVIDENCE, R. I.—GRINDING AND POLISHING MACHINERY.

MACHINERY HALL—EXHIBIT OF THE CLEVELAND TWIST DRILL CO., CLEVELAND, OHIO—METAL-WORKING TOOLS.

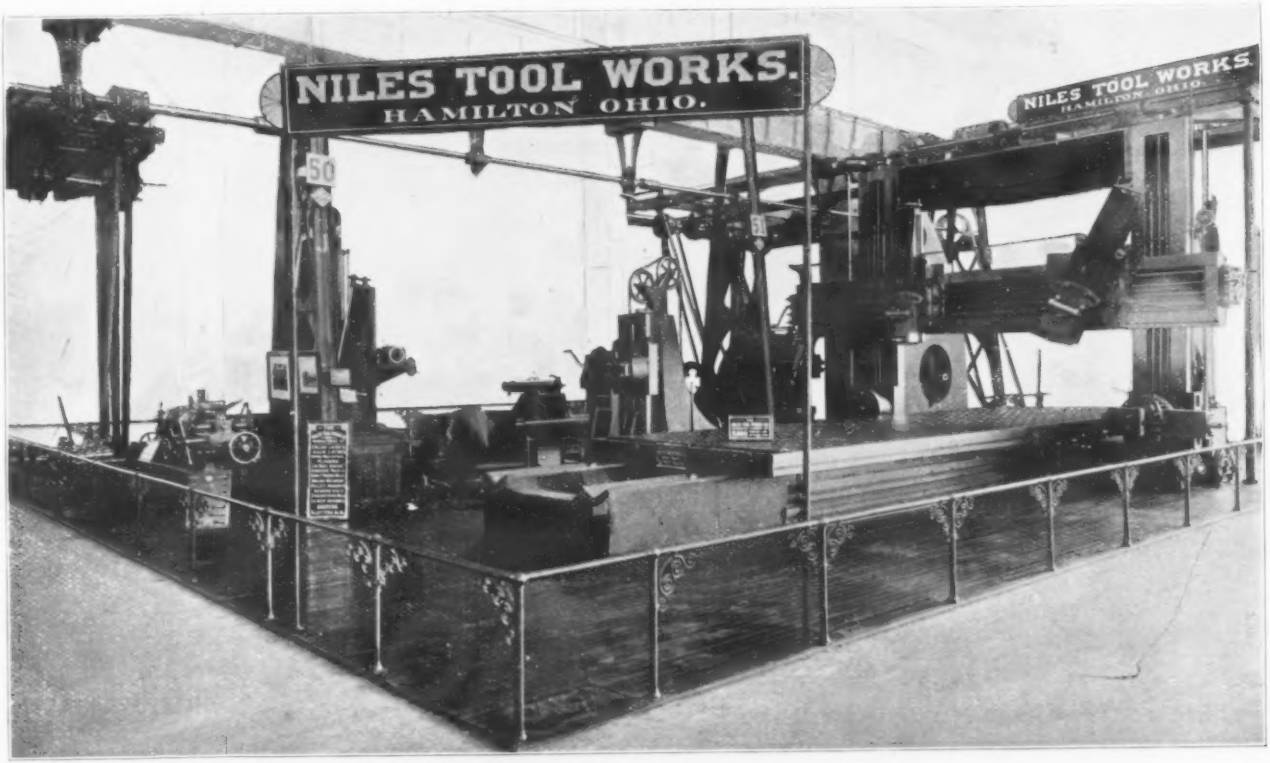
VOLNEY W. MASON & CO.
HOISTING MACHINERY
PATENTS IN EUROPE.
PETRUS REGOUT & CO. MAASTRICHT, HOLLAND.
L. A. PRAVT, KAISERSLAUTERN, BAVARIA, GERMANY.
WM. BRATT & CO. ST. PETERSBURG, RUSSIA.

MACHINERY HALL.—EXHIBIT OF VOLNEY W. MASON & CO., PROVIDENCE, R. I.—HOISTING MACHINERY AND PULLEYS.

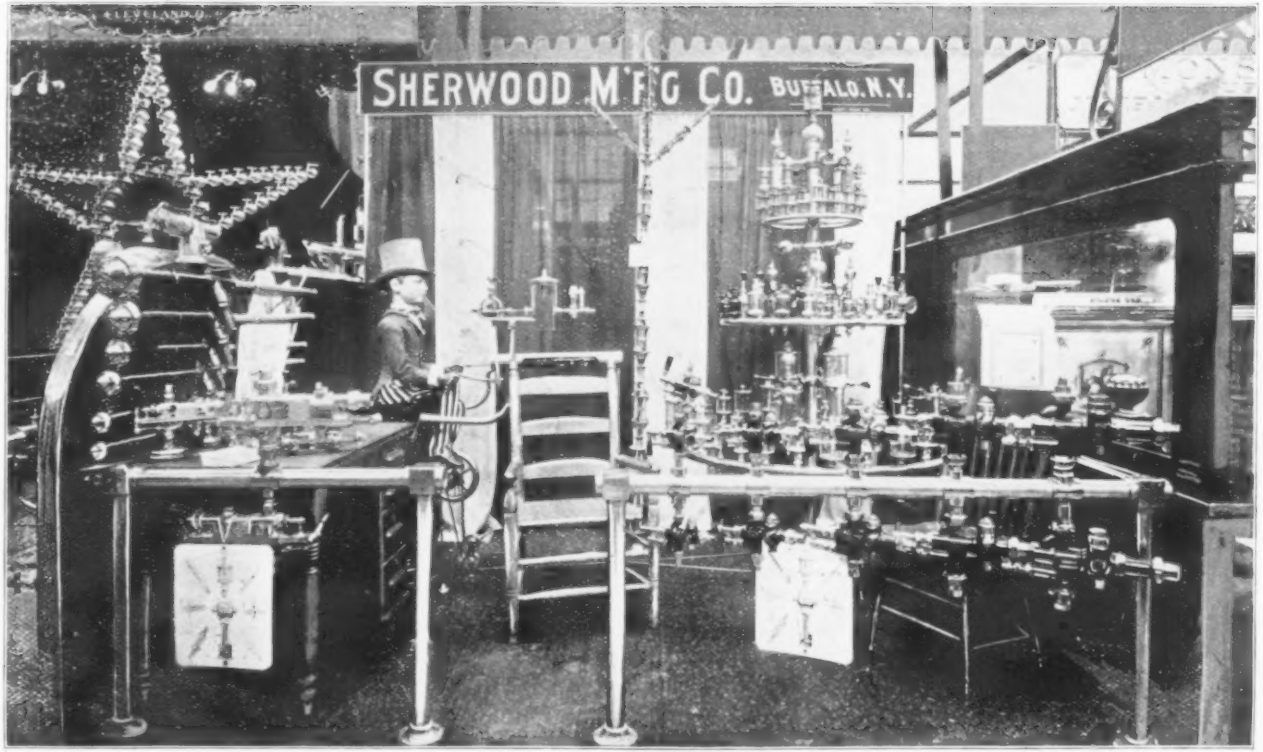


MACHINERY HALL.—EXHIBIT OF THE LAIDLAW-DUNN-GORDON CO. CINCINNATI, OHIO.—PUMPS AND PUMPING MACHINERY.

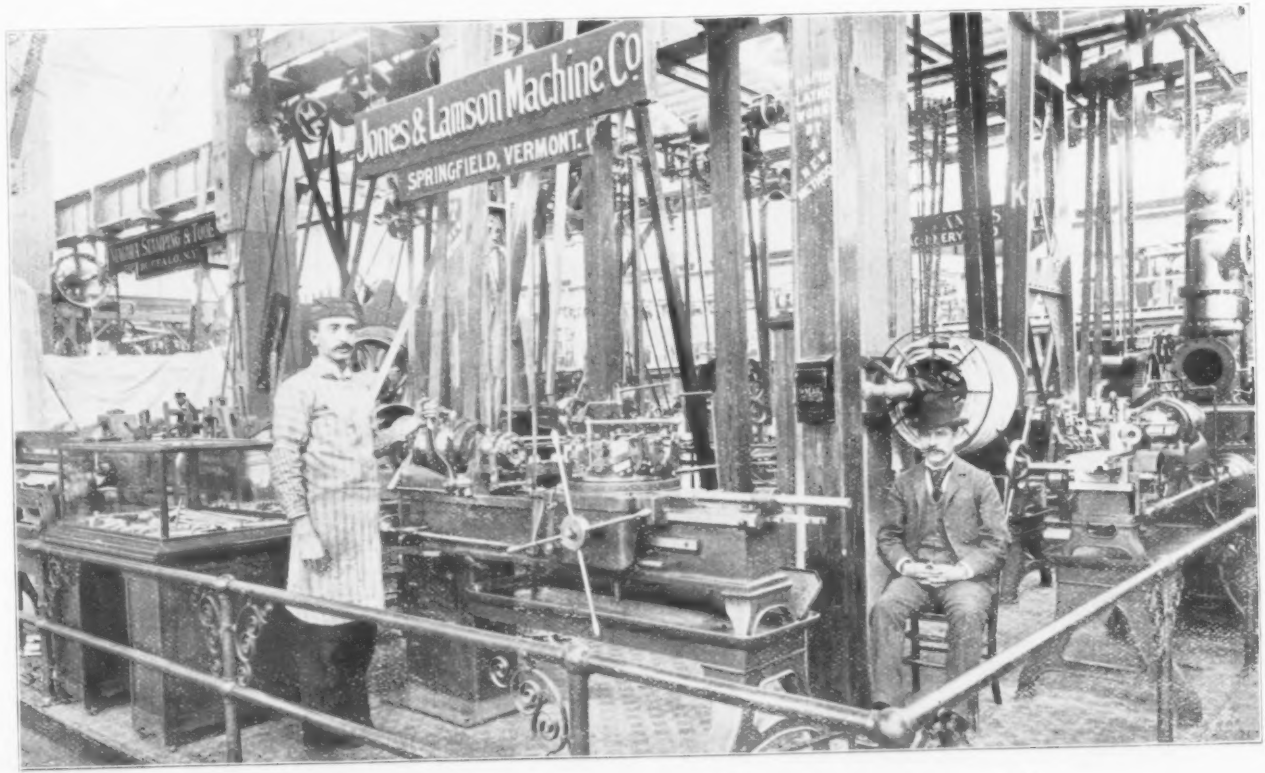
MACHINERY HALL.—EXHIBIT OF THE BILLINGS & SPENCER CO., HARTFORD, CONN.—DROP FORGINGS.



MACHINERY HALL.—EXHIBIT OF THE NILES TOOL WORKS, HAMILTON, OHIO.—MACHINE TOOLS.

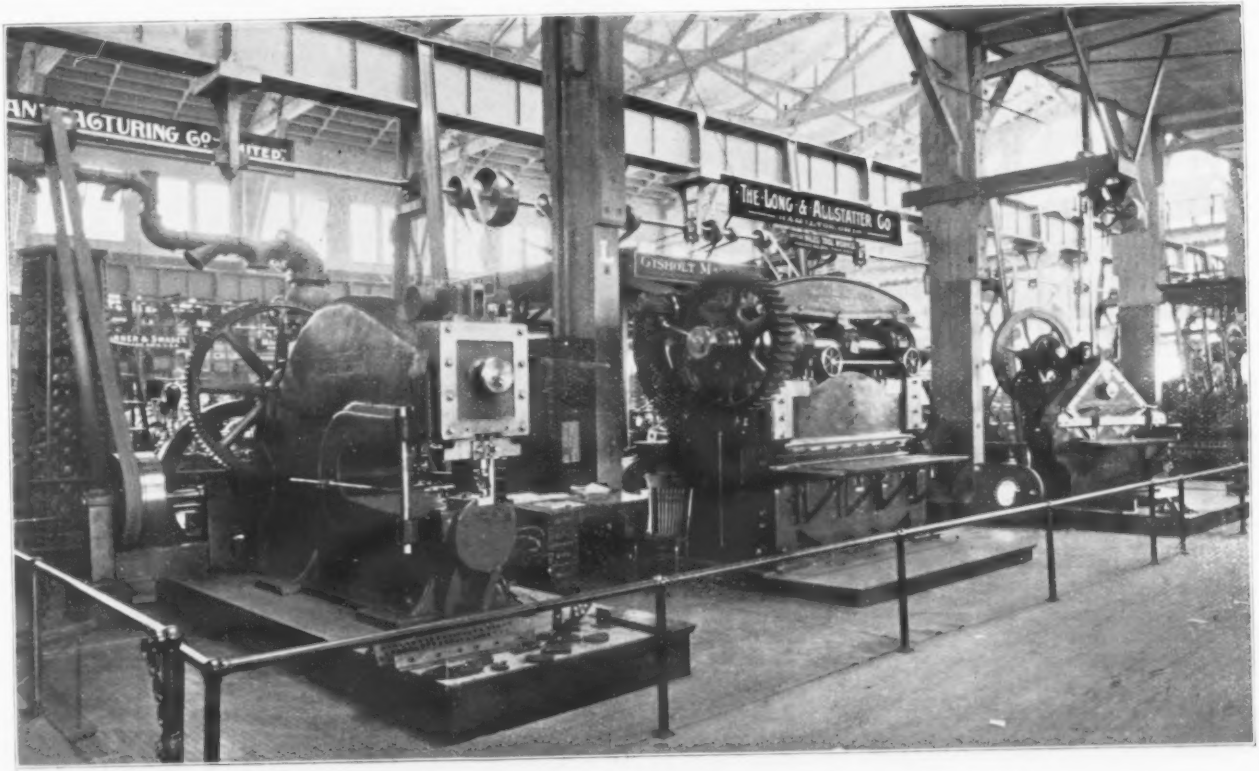


MACHINERY HALL.—EXHIBIT OF THE SHERWOOD MFG. CO., BUFFALO, N. Y.—ENGINE-ROOM SPECIALTIES.

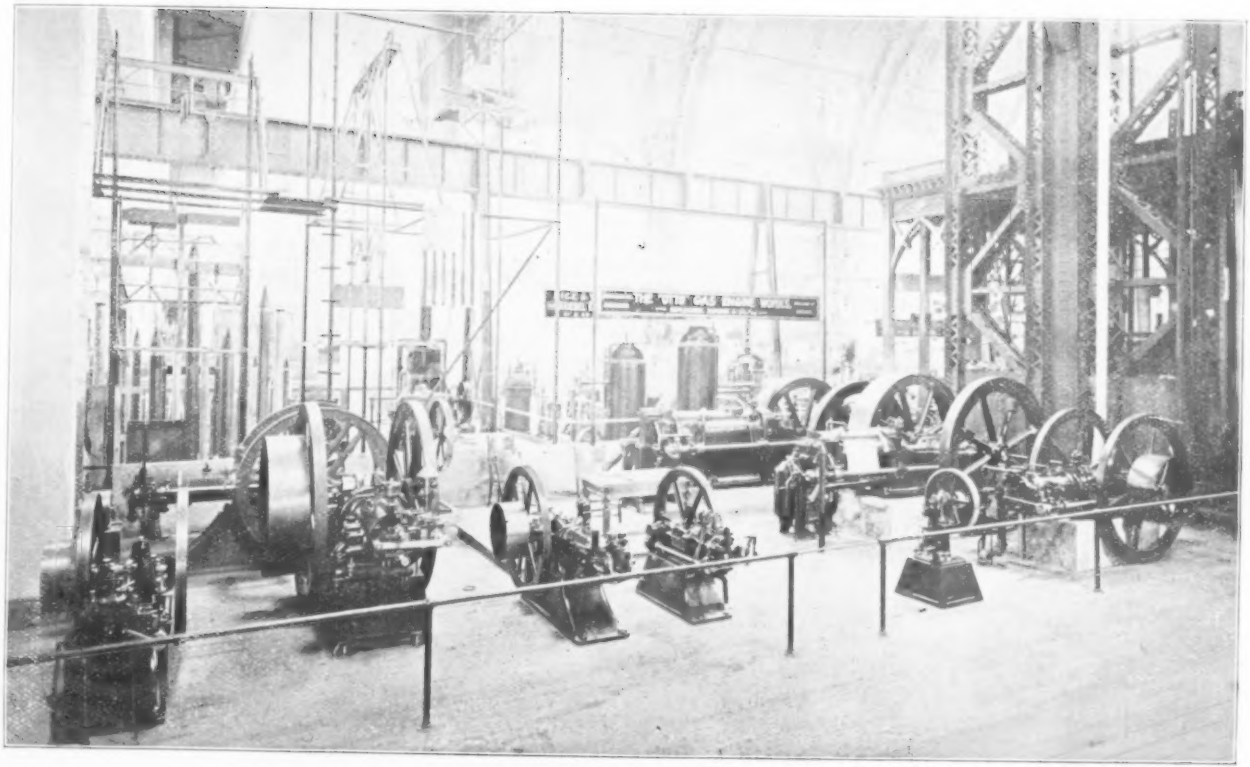


MACHINERY HALL.—EXHIBIT OF THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VT.—MACHINE TOOLS.

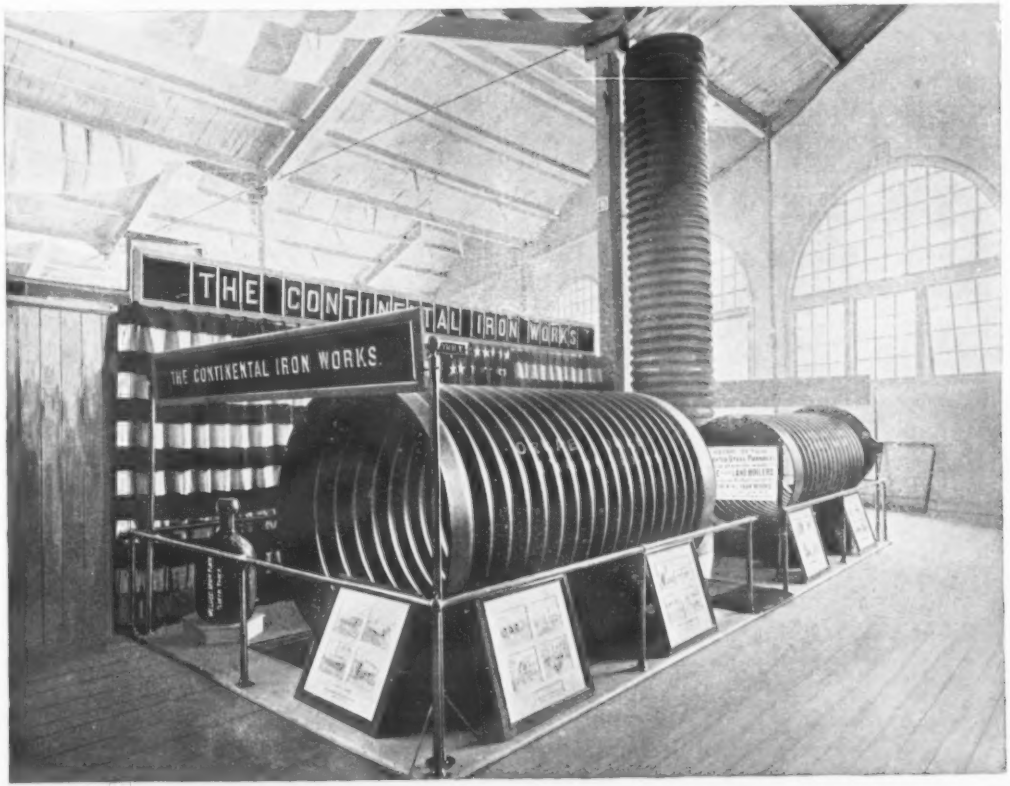
MACHINERY HALL.—EXHIBIT OF THE E. W. BLISS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.



MACHINERY HALL.—EXHIBIT OF THE LONG & ALLSTATTER CO., HAMILTON, OHIO.—MACHINE TOOLS.



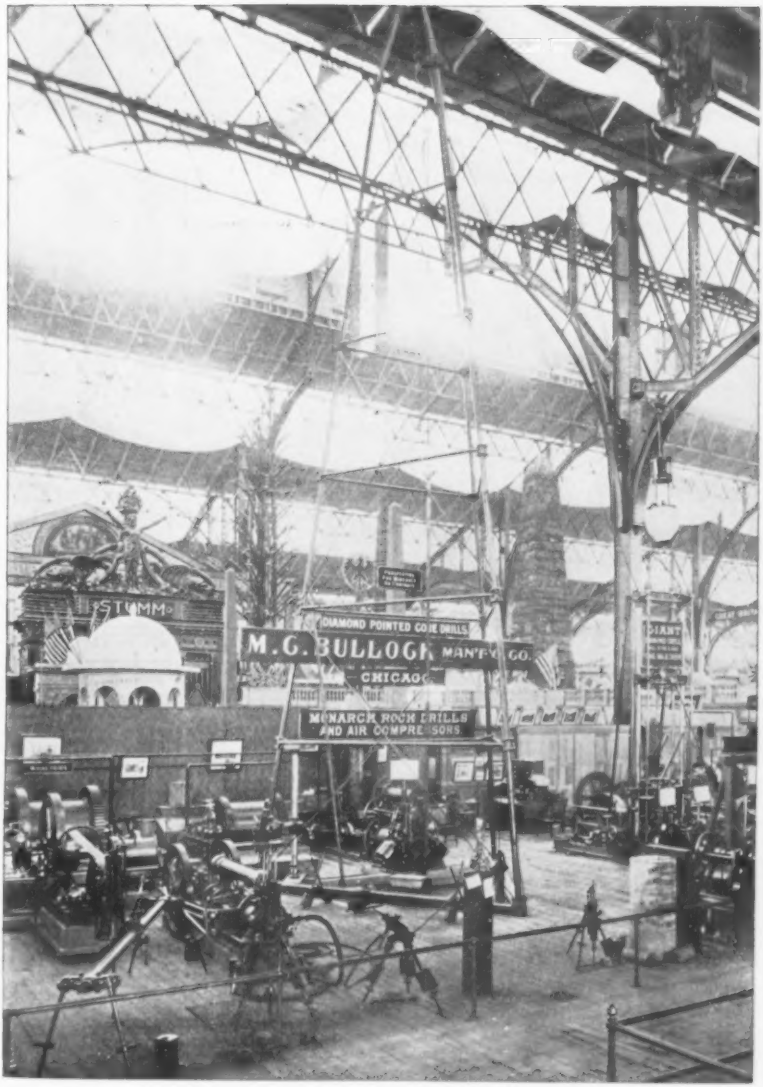
MACHINERY HALL.—EXHIBIT OF THE OTTO GAS ENGINE WORKS, PHILADELPHIA, PA.



TRANSPORTATION BUILDING—EXHIBIT OF THE CONTINENTAL IRON WORKS, BROOKLYN, N. Y.—CORRUGATED MARINE BOILER FURNACES.

MANUFACTURES & LIBERAL ARTS BUILDING.—THE EXHIBIT OF FAIRBANKS' SCALES—FAIRBANKS, MORSE & CO., CHICAGO.

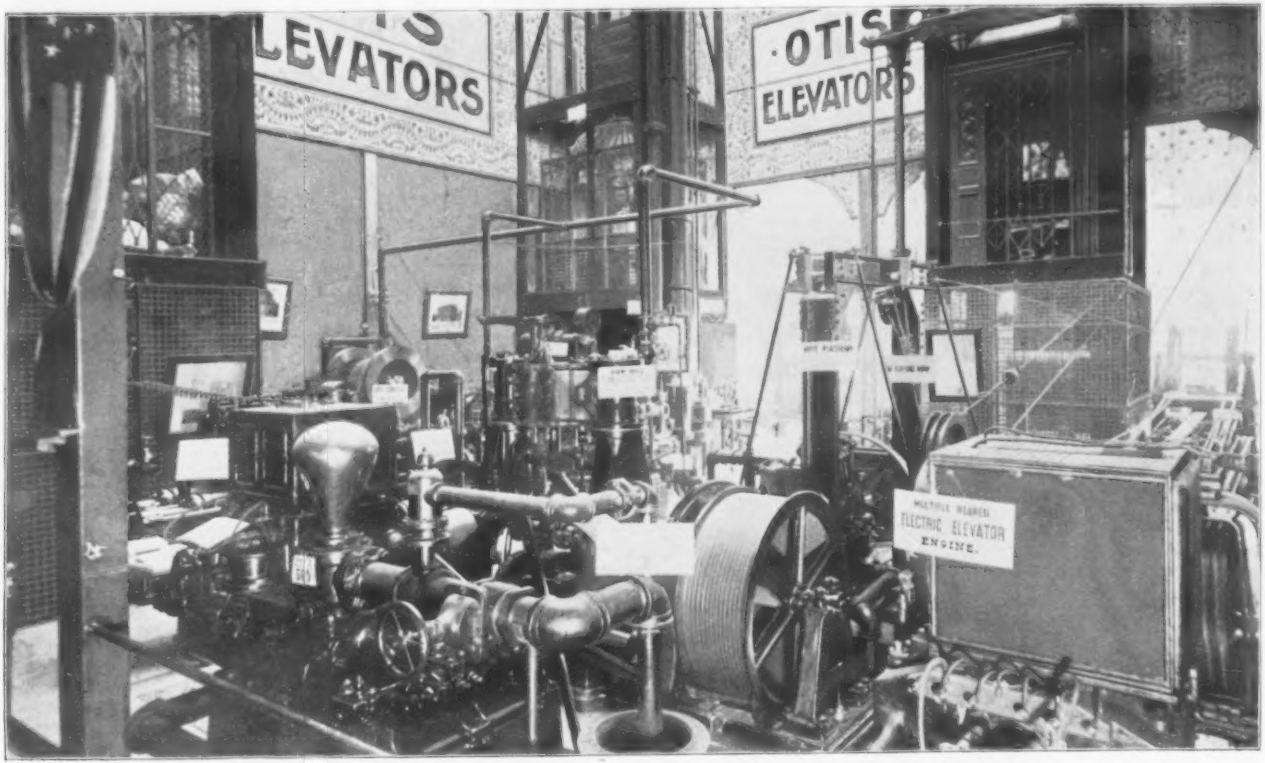
(The largest, most varied, and finest exhibit of scales ever shown in the world.—Floor space occupied 3000 square feet.)



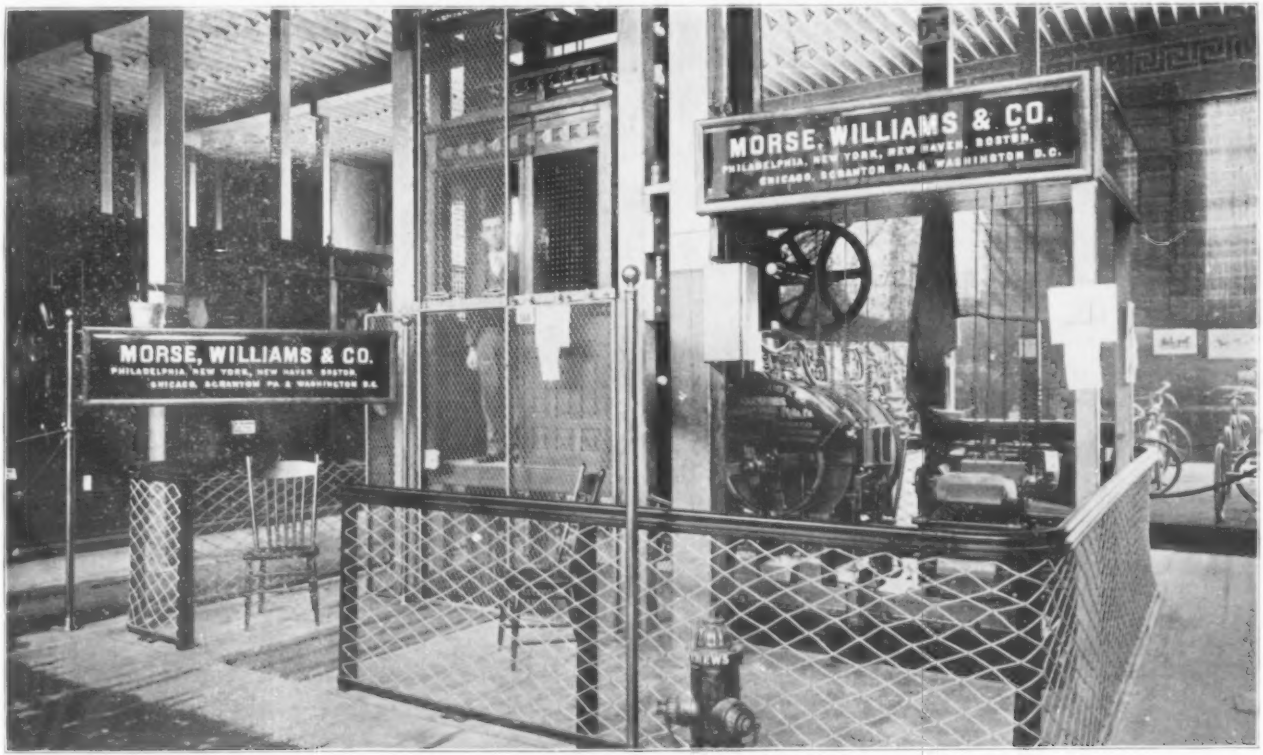
MINES & MINING BUILDING.—EXHIBIT OF THE M. C. BULLOCK M'F'G CO., CHICAGO.—ROCK DRILLS, AIR COMPRESSORS, CORLISS ENGINES AND GENERAL MINING MACHINERY.

MINES & MINING BUILDING—EXHIBIT OF THE CHROME STEEL WORKS, BROOKLYN, N. Y.—SHOES AND DIES FOR STAMP MILLS, AND VAULT STEEL.

ELECTRIC, HYDRAULIC AND STEAM ELEVATORS.

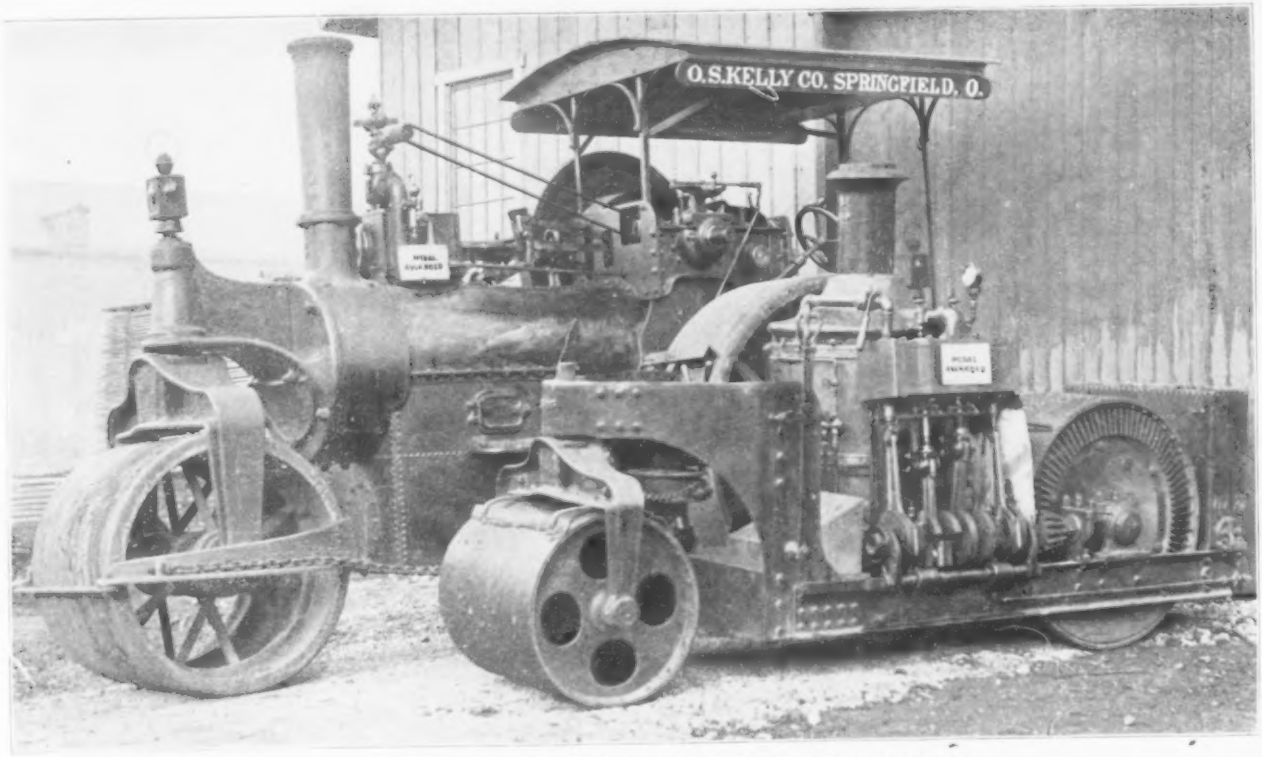


TRANSPORTATION BUILDING—EXHIBIT OF OTIS BROS. & CO., NEW YORK.—ELECTRIC, HYDRAULIC AND STEAM ELEVATORS.



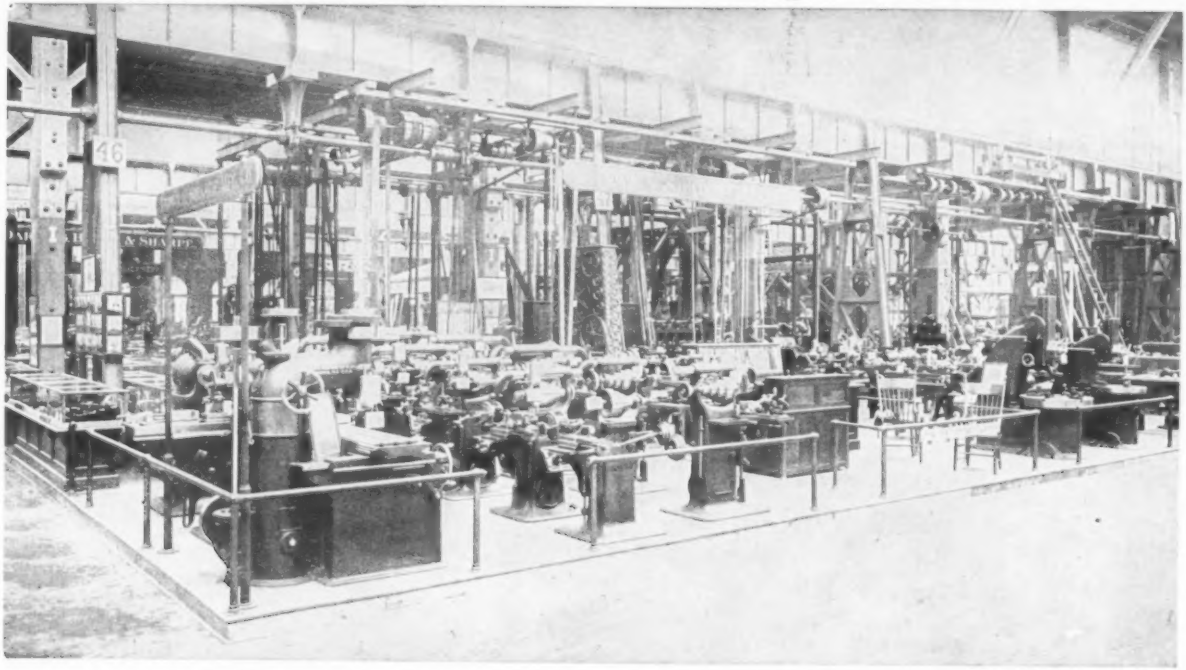
TRANSPORTATION BUILDING—EXHIBIT OF MORSE, WILLIAMS & CO., PHILADELPHIA, PA.

A Direct Electric Elevator in constant use during the Exposition conveying passengers to the galleries of the building.

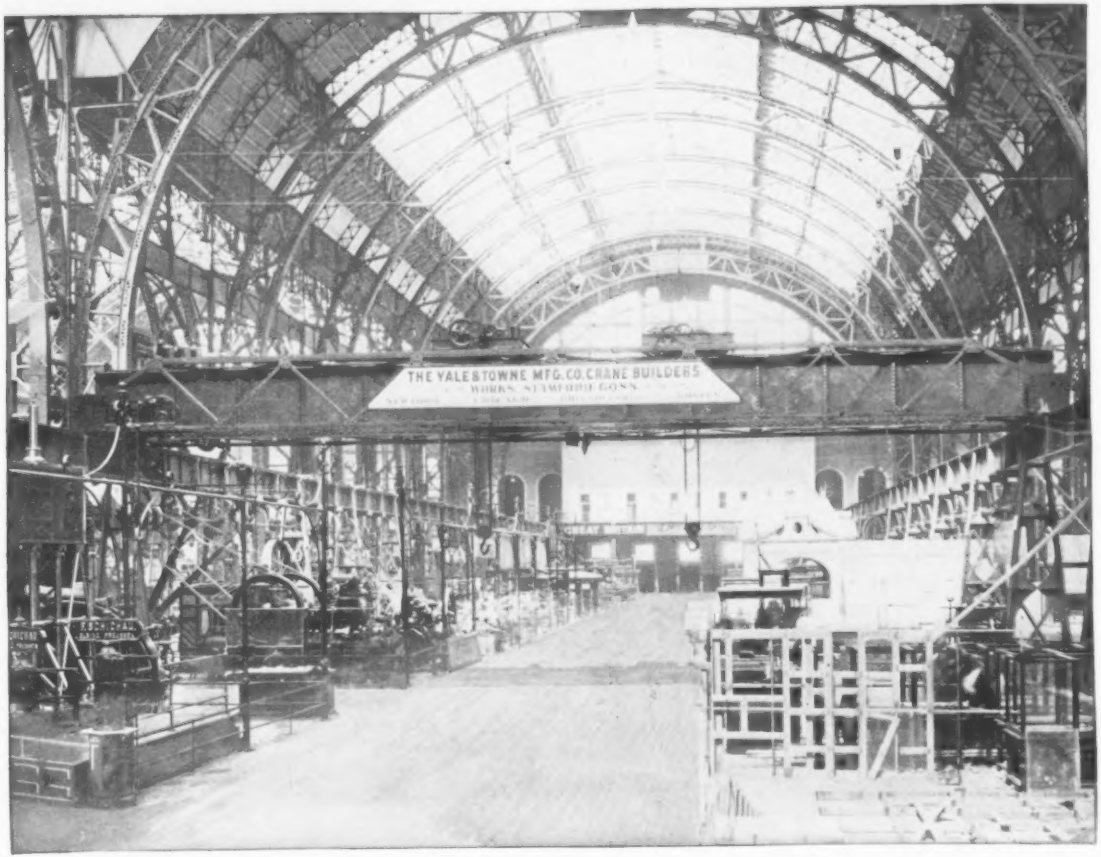


THE SPRINGFIELD STEAM ROAD-ROLLERS—O. S. KELLY COMPANY, SPRINGFIELD, OHIO.
Actively employed for 18 months in making the road-ways of the Fair grounds.

MACHINERY HALL—EXHIBIT OF THE YALE & TOWNE MFG. CO., STAMFORD, CONN.
A 20-ton High Speed Electric Traveling Crane in practical use for placing heavy exhibits.



MACHINERY HALL—EXHIBIT OF THE BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.—MACHINE TOOLS.



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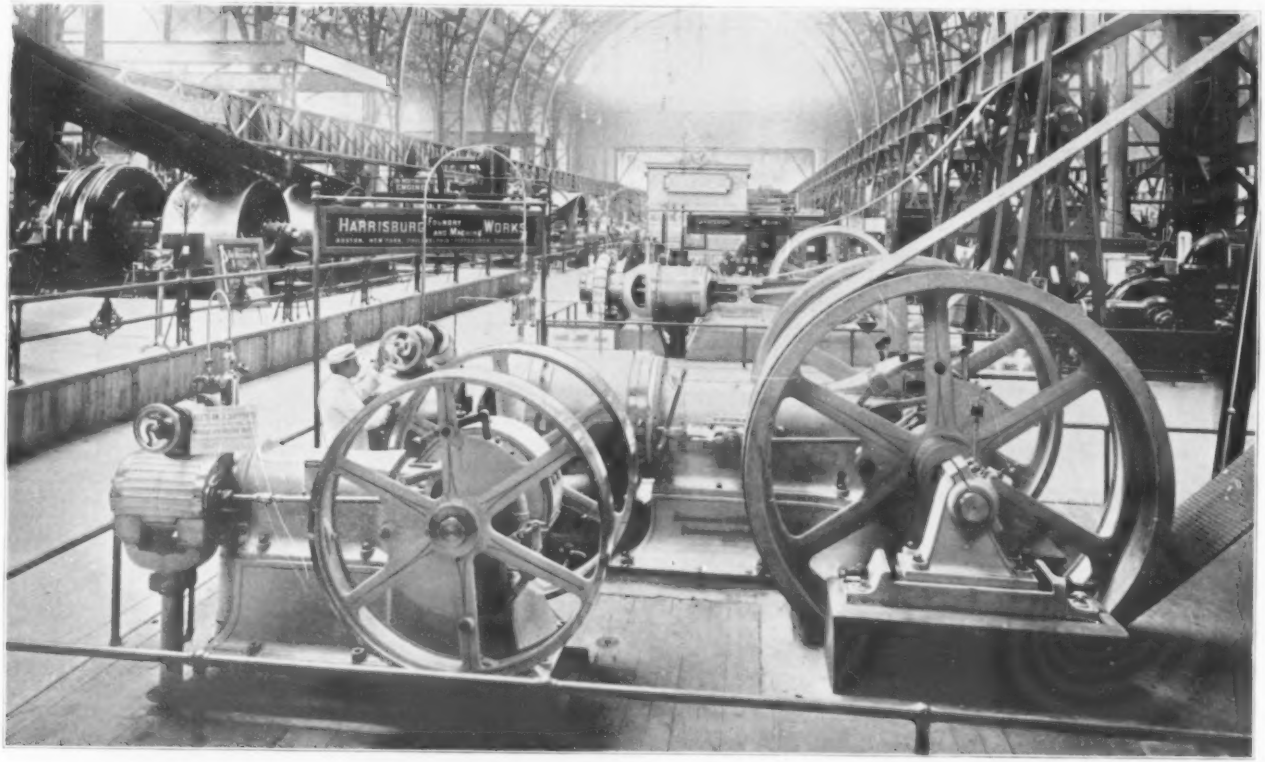

MACHINERY HALL—EXHIBIT OF THE HARRISBURG FOUNDRY AND MACHINE WORKS, HARRISBURGH, PA.—IDE AND IDEAL AUTOMATIC CUT-OFF ENGINES.